SCIENTIFIC AMERICAN SUPPLEMENT

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VOLUME LXXXV
NUMBER 2212

★ NEW YORK, MAY 25, 1918 ★

10 CENTS A COPY
$5.00 A YEAR

The Gilliams Service

Gathering sap from a maple tree in the Vermont hills for sugar making

THE MAPLE TREE HELPS TO REDUCE SUGAR SHORTAGE [See page 324]

Types of Military Airplanes*

The Possibilities of the Bomber

By Col. V. E. Clark

The military types of aeroplanes, as influenced by the military functions and as influencing the design of the engine that goes into the aeroplanes, will be the subject of this brief discussion.

The Allies have run to more types than the enemy. One of the main reasons for this is that the Allies have listened more to the demands of their fliers, who have exerted much influence on plane and engine design. Thereby, standardized production has been sacrificed to individual requirements.

It will be America's part in the aircraft program to select those types that best lend themselves to big production—to look ahead six or twelve months in an endeavor to anticipate the advance requirements, and then design those types in such a way that they can be built on a large scale. Standardization means fewer types—greater numbers of machines. We must select perhaps five or six types, develop them, and *produce* them by the thousands. We should select for standardization from the following types:

(1) Airplanes of Observation.
(2) Aeroplanes of Combat and Pursuit.
(3) Aeroplanes of Destruction and Harassment.
(4) Special Types.

None of these types is new. All can be developed to a far greater degree of efficiency than those now being used. Each type has a different function. Aeroplanes of observation must aid the army on the ground in successfully performing its operations. Those of combat and pursuit must prevent enemy aircraft from doing damage in any way. Those of destruction and harassment will inflict direct damage on the enemy. With special types we have little concern. Of chief concern to me—to the Aircraft Board—to America—in fact, to the world, are those planes that will inflict direct damage on the enemy. They are the bombing machines, upon which depends a substantial part of the measure of victory, of that I am convinced.

The need for these being recognized and vital, and the hour of their initial production being at hand, I shall confine my remarks to a limited discussion of their possibilities.

Bombing operations provide practically all the real damage that it is, at present, possible for an aeroplane to inflict upon the enemy. In comparison to these the slight damage caused by bringing down his aeroplanes, each containing one or two men only, or shooting up his trenches or truck trains, is negligible.

The enemy should be harassed continually from the air. Two classes of bombers must be employed—day bombers and night bombers.

USE OF DAY BOMBERS

Under present conditions along the Western front *material* damage must be done at night. Day bombers will be used solely for the moral effect of inflicting perpetual unrest except in a few special cases when vulnerable objectives are difficult to locate at night.

The primary military functions of the day bomber are:

(1) To bomb important points, such as small objects difficult to find by night, headquarters, small ammunition "dumps," small storehouses containing munitions or supplies, small railway junctions, and small aerodromes.

(2) To bomb such communities as is considered desirable, especially factories and factory towns.

(3) To conduct long-range reconnaissance, strategical reconnaissance, reconnaissance by staff officers, or with camera.

(4) To do special photographic work so far beyond the lines as to necessitate great altitude, demanding a camera of great focal length and therefore great size and weight.

The primary requirements for this aeroplane in order that it can effectively perform its military functions are:

(1) Ability to protect itself effectively against all hostile aircraft, which demands good speed at altitude, strong climbing ability, powerful and reliable armament, and a satisfactory degree of "handiness."

(2) Reliable powerplant.

(3) Powerplant with good fuel efficiency.

(4) Capacity for as many bombs as will not prohibit satisfactory provisions for protecting itself against enemy aircraft as discussed above. I believe that, at the present time, it is not an economic proposition to send a trained pilot and a trained "bombardier" a great distance beyond the enemy's line unless at least 600 pounds of bombs are carried.

(5) Effective provision for accurate sighting of and dropping bombs.

(6) Ceiling should be high enough so that the machine stands a good chance of escaping detection as it crosses the line.

(7) Muffler for the exhaust capable of being cut in and off at the will of the pilot.

(8) Two or three machine guns, one firing through the propeller disk and one or two with all-around fire, with good field to the rear.

(9) Provision to carry two men.

(10) Reliable Compass.

Typical aeroplanes of the day bomber type are the DeHaviland-9 (British), with 300-hp. Fiat engine; the S. I. A. 7-B (Italian), with 200-hp. Fiat engine; the S. I. A. 9-B (Italian), with 500 hp. Fiat engine, and the Breguet 14-B2 (French), with 300-hp. Renault engine. The German Gotha twin-engine machine (two 260-hp. Mercedes engines), while rather too slow and too unhandy for the purpose, has done some service bombing by day over London.

NIGHT BOMBERS

The type designed for bombing by night, in my opinion, must be depended on to inflict real material damage upon the enemy. I believe that the consistent employment of these machines in large numbers on every good moonlight night to bomb Germany's munition factories, factory towns, important railway junctions, large munition depots, the bridges across the Rhine, the Kiel Canal, important docks, submarine bases, and certain cities, would end the war in a shorter period of time than is possible by any other means.

The primary requirements for these machines in order that they can effectively perform their functions are:

(1) Great bomb capacity.
(2) Reliable powerplant.
(3) Powerplant with good fuel efficiency.
(4) Proper degree of stability and controllability to permit a pilot of ordinary ability, and a limited amount of training to fly and land at night.
(5) Effective provision for accurate sighting for, and dropping of bombs.
(6) Accurate compass and other instruments necessary for navigation by night, with provision for reading conveniently at night.
(7) Provision for carrying two to five men. Probably the best practice is a crew of three, a chief pilot, a "bombardier," and one man to man a gun forward or to the rear, as may be necessary, and to act as relief pilot.

The load of bombs that can be carried will depend upon the total power available at an altitude of 10,000 feet, and upon the distance of the objective (which will regulate the initial fuel supply). The ratio of total weight of aeroplane, with full initial load, to the total power available should be small enough to permit a ceiling of at least 11,500 feet, starting with full load. The power plant will be divided into two or possibly three units. Suppose that two U. S. A. twelve-cylinder engines be installed; if no device is incorporated to maintain the power constant with change in altitude, the total power available at 10,000-ft. altitude should be about 450 horsepower. Suppose that the objective lies 155 miles beyond the lines, a bomb load of between 2,000 and 2,700 pounds can be carried, and the necessary initial ceiling obtained, provided the general design of the aeroplane be good.

LIMITING WEIGHT

The total weight of the aeroplane in pounds with full initial load should not be more than 22 times the number of horsepower available at 10,000 feet. The total weight should not be more than 5.63 pounds per square foot. The machine should have possible horizontal speed, at an altitude of 10,000 feet of not less than 85 miles per hour. Starting with full load the aeroplane should be capable of climbing to an altitude of 10,000 feet in not more than 27 minutes. For every 16 miles increase in radius necessary to reach the objective, 100 pounds of bombs is sacrificed.

Typical aeroplanes of the night bomber type are the Caproni triplane (Italian) with three 273-hp. Isotta-Fraschini engines; the Handley-Paige (British) with 320-hp. Sunbeam engines, and the Caproni biplane with three 210-hp. S. P. A. engines. The German Gotha, with two 260-hp. Mercedes engines, is typical.

The number of night-bombing aeroplanes built and supplied should depend solely upon the number of pilots available for this work. A far lower degree of flying skill is required to pilot a large slow night bomber than for a fast fighting machine, although more mature judgment is necessary.

As a matter of fact, the number built and supplied will, in all probability, eventually depend upon steamship space for trans-Atlantic transportation and upon the hangar space at the aerodromes in France, and possibly upon the appropriation available.

AIR RAIDS WITH BOMBS

Consider, for example, a fleet of several hundred of night-bombing aeroplanes, each carrying a ton and a half of bombs, flying from large aerodromes located say 25 miles to the rear of the line. The fleet penetrates to Essen, for instance. Each machine locates its objective and drops ten 160-pound bombs of the high-explosive type on the factories and forty 25-pound bombs filled with poisonous gas, and twenty-four 25-pound bombs of the incendiary type throughout the factory town, and returns home.

In the existing phase of the present war were our night-bombing aeroplanes of sufficient numerical strength it would be no longer a matter of individual and isolated raids on selected places at which the maximum of injury could be inflicted, but rather a continuous and unrelenting attack on every point of strategical importance.

Depots of every kind in the rear of the enemy's lines would cease to exist; rolling stock and mechanical transport would be destroyed; no bridge would be allowed to stand for twenty-four hours; railway junctions would be subject to continuous bombardment, and the lines of railway and the roads themselves broken up nightly by giant bombs to such an extent as to baffle all attempts to maintain or restore communication.

In this manner a virtually impossible zone would be located in the rear of the enemy defenses, a zone varying from 100 to 200 miles in width. As soon as this condition has been brought about, the position of the defending force must be considered as precarious, and eventually impossible. The defense will be strangled from the uncertainty and lack of supplies of all kinds. Ultimately retreat will become impossible. The defending force will find itself in a state of siege under the worst possible conditions. Its position will be in the form of an extended line along which the forces of all arms will be definitely immobile, for the lateral communications will suffer no less than the lines from the rear. In short, a reign of terror would exist. Such a condition presents all the elements conducive to complete and irreparable disaster.

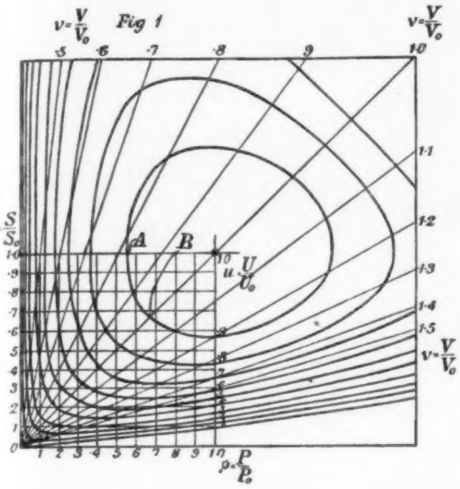
Everyone here, I think, will realize that even consistent bombing of factory towns would end the war surely and quickly.

*A paper presented at the annual meeting of the Society of Automotive Engineers and published in the *Journal* of the Society.

Aeroplane Limits

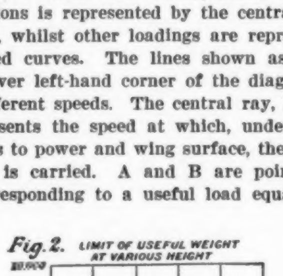
It is a commonplace of bridge engineering that there is a fixed limit to the length of span possible with a given type, since the weight of the structure goes up rapidly as the span is increased, and at some limit of span becomes so large that the bridge would break down under its own deadweight acting alone, even without the added burden of the traffic to be accommodated. The limiting useful span is that at which the stresses due to the weight of the structure plus that of the traffic reach the safe limit, and an increase of span beyond this is impracticable without a change either in the type of bridge or in the materials with which it is made. The supporting surfaces of an aeroplane are subjeect to the same law—that their weight increases with increase of dimensions more rapidly than their strength does, and this would in itself suffice to fix a limit to the possible size of aeroplanes. Matters are, however, still worse when allowance is made for the fact that level flight is impossible without engine power, and hence, before the wings can carry any useful load whatever they must be able to support not only their own weight and that of their essential

structural elements and connections, but also that of the engine. It is thus only the balance of sustentation left after deduction for these that is available for supporting the useful load, which will include the weight of the crew and of all other weights which are not in the shape of fixtures or engine supplies.



In a recent issue of *The Aeronautical Journal* Lieutenant A. R. Low, R. N. A. S., has given some interesting curves showing how the useful load in any machine will vary if the conditions differ in any way from the optimum. In a paper read before the Junior Institution of Engineers in April, 1913, he established rational relationships between the useful load carried and the engine weights, the structural weights, and the coefficients of sustentation and of resistance, and from these he has now plotted the curves reproduced in Fig. 1. These curves are applicable to any and every aeroplane, and show at sight how with a given type the performance will vary with changes in the engine power, wing surface and speed. For every type there is, in fact, some one combination of power surface and speed which is most effective, as estimated by the useful load carried. Thus let P_0 denote the power expended under these conditions, and S_0 the corresponding wing surface, whilst V_0 denotes the speed, then if U_0 be the useful load then carried, the relation between these various quantities at any other load is deducible from the curves plotted in Fig. 1. The isolated central point of the diagram represents the conditions corresponding to the maximum possible load. This can be carried only at one speed and with one power. If the power be increased beyond this value the consequent increase in engine weights will diminish the possible useful load carried. These useful loads are plotted as contour lines, of which that corresponding to the optimum conditions is represented by the central point of the diagram, whilst other loadings are represented by the numbered curves. The lines shown as radiating from the lower left-hand corner of the diagram correspond to different speeds. The central ray, lettered as $v = 1$, represents the speed at which, under optimum conditions as to power and wing surface, the maximum useful load is carried. A and B are points on the contour corresponding to a useful load equal to nine-

Fig. 2. LIMIT OF USEFUL WEIGHT AT VARIOUS HEIGHT



tenths of the optimum. If the wing surface be the same as in the best conditions, then this useful load of nine-tenths will be carried with an expenditure of only about 0.56 of the power required at the maximum useful effect, and this reduction of the power by 0.44 will reduce the speed by about 0.18 only. The reduction of power is shown by the point where the contour 0.9 cuts at A the horizontal line through the center of the figure. By reducing the surface to about two-thirds of its optimum value, this same load of nine-tenths of the maximum can be transported at the same speed of the machine as in the optimum conditions with an expenditure of about two-thirds of the power required to carry the maximum load. This is indicated by the point B, where the contour 0.9 cuts the ray $v = 1$. Similar conclusions follow when the useful load is still further reduced, as is clearly shown by the corresponding contour lines. In general, aeroplane practice lies wholly within the lower left-hand quarter of the complete diagram. In some cases, however, it has been found desirable, for certain purposes, to go outside these limits, which is accomplished by reducing the fuel and oil supplies carried. The useful load can in that case be increased, but the length of flight possible is, of course, diminished. The curve shown in Fig. 2 represents, Lieutenant Low states, about the maximum useful loads with which flight is now possible at the different levels indicated, though there are indications that improvements in materials and in the design of details may ere long yield results better than those represented by the curve. The numerical results merely represent the machine ideally possible on the basis of the data of 1912, and though the limits indicated by the curve have only now been reached after five years of exceptionally rapid progress, they must not be taken as final. Every reduction in engine and structural weights obtained by better design or by cutting factors of safety puts up the value of the useful weight carried nearly as the square of the value of the improvement. The curve has been plotted on the basis that the fuel tanks are full, carrying the normal supply of petrol. The heights shown are the "ceiling" heights of the machines with different weights on board. As a machine rises, the density of the air diminishes and its sustaining power falls off. The ceiling height of a machine is the limit to which it is possble for the machine to climb. At this limit the machine can just fly horizontally when developing its maximum engine power. If an attempt be made to rise above this "ceiling" height by increasing the angle of attack, the speed falls off because the head resistances are increased and the engine revolutions and horse power diminish accordingly, with the result that the machine begins to come down. If, on the other hand, the angle of attack is diminished, the speed will rise and the engine power go up, but the angle of attack is then too small to sustain the weight, and the machine descends, as in the previous case. The limit of useful load varies approximately as the cube of the density of the air, which diminishes rapidly as the height increases. The abscissæ $\left(\frac{\rho}{\rho_0}\right)^3$ denote the relative densities at different heights.—*Engineering*.

On the Theory of Electrodynamics

A difficulty which arises in every theory of electromagnetic processes with respect to moving bodies, is that the experiments both of Fizeau and of Michelson must receive explanation. It follows from the former that ponderable matter does not carry the ether with it when in motion, and so the acceptance of an absolute stationary ether is necessitated. If this be the case, it is only a matter of accuracy to establish motion relative to the ether. This was the object of Michelson's experiment, and from the negative results obtained it followed either that there is no motion relative to the ether, or, that such is incapable of being experimentally established. Lorentz, to explain the latter, assumed that every body by virtue of its motion undergoes dimensional change in the direction of motion, while Einstein has attained the same standpoint by the introduction of a new time idea. Since the latter idea is bound up with other physical fundamentals, it is, therefore, possible to evolve a consequent physical system in which all expressions connected with the time idea must undergo corresponding change. Relating to the above, Ritz has developed a theory in which the active forces between the electrons depend only on the relative velocities, and he regards every electron as attached to a material article possessing the velocity of light, and radiating according to the laws of relative motion, the force at every particle being proportional to its density. Since only activity is assumed between the electrons, Fizeau's experiment remains unexplained, and, since the particles after loss of the electrons move according to the laws of gravitation, the theory is inapplicable to optics. The present author now submits another theory for the removal of the apparent contradiction between the experiments of Fizeau and Michelson. If the fundamentals of the Lorentz electronic theory be accepted, this will involve the assumption that all electromagnetic processes are to be traced to the activity of electrons, and the two facts to be explained are: (1) If ponderable matter moves in a field of oscillating electrons, the ether remains at rest; (2) if a source of light (an oscillating electron) moves, then the propagation of light follows as if the light-source carried the ether with it. These two apparently contradictory facts can be reconciled by the assumption that there is not one unique ether, but that every electron possesses an ether which it carries with it during motion. Since ether in the electromagnetic sense is a polarizable body without mass, there is nothing absurd in the assumption. In a corresponding mechanical theory on the other hand, the mass of the ether must be finite, and the density inversely proportional to the fourth power of the distance from the electron. Such an ether would correspond better with the atomic hypothesis. The conditions now to be fulfilled are that the radiation only depends on the acceleration, and that the reciprocal activity of two electrons only depends on their relative motion. The first condition involves the removal of the absolute velocity term from the Lorentz expression for the field strength of an electron, with suitable modifications for the remaining terms. The second condition involves the aid of Riemann's fundamental proposition. The paper includes a mathematical exposition of the author's theory based on these assumptions. An expression for the field strength of an electron in the ether has been tentatively obtained by a combination of the elementary laws of Riemann and Lorentz which correctly explains all electromagnetic phenomena with the exception of the β-radiation. In order to account for the latter, the theory must be further extended.—Note from *Science Abstracts* in an article by R. Malmström in *Phys. Zeits.*

Manufacture of Silica Bricks

Silica bricks were made by grinding silica from different sources with milk of lime for ten minutes and then moulding the product by hand. The bricks were dried on cast iron plates at about 100° C. and were then burned at 1,300° C. in a down-draught kiln. Crushing tests were made by placing two half bricks one above the other in the testing machine. Refractoriness tests were made on pieces cut to the same shape and size as standard cones and then heated steadily in a corundum cylinder in a furnace using acetylene and compressed air or oxygen. It was found that the highest crushing strengths were possessed by bricks in which the quartz was most finely ground; bricks made of impalpably fine quartz with 2 per cent lime had a crushing strength of 18 kilos when dried, and 320 kilos, when burned at 1,300° C., but similar bricks made of quartz particles 0.13 mm. diameter had crushing strengths of only 2 kilos and 16 kilos. respectively. Notwithstanding the differences in the geological origin and physical characters of the various forms of silica used, they all were capable of producing bricks of great strength if the raw material was sufficiently finely ground. The minimum crushing strength of bricks made from impalpably fine quartz was found to be 200 kilos. per sq. cm. The expansion produced on burning the bricks is greatest with those containing large grains. The expansion of bricks made of impalpable quartz is almost nil. The crushing strength of the bricks is increased by the use of relatively large quantities of water in the paste of which they are made. The strength of the dried bricks varies with the proportion of lime present; that of the burned bricks increases with the proportion of lime up to 1 per cent, then remains constant up to 2 per cent and diminishes with still larger proportions. Each 1 per cent of lime lowers the refractoriness by about 20° C. Bricks made of impalpable quartz begin to soften at 800° C.; at 1,200° C. they have a crushing strength of 190 kilos. per sq. cm. and 270 kilos. per sq. cm. at 1,300° C. Bricks containing larger grains of quartz do not begin to soften below 1,100° C., but at 1,300° C. they have a crushing strength of only 70 kilos. per sq. cm. Tests on bricks made of impalpable quartz mixed with larger grains showed that the most refractory bricks contained the least quantity of impalpable powder and that grains of 8 mm. diameter are the largest permissible in good bricks. On applying the foregoing results to commercial manufacture, it was found best to use material with at least 96 per cent silica, the precise form being unimportant so long as 30 per cent of it is in impalpable powder and 70 per cent in grains of 1—8 mm. diameter. The proportion of lime added was only 0.6 per cent of the bricks, but 2 per cent of the "flour." The bricks fired in a tunnel kiln at 1,300° C. had a crushing strength of 200—250 kilos. per sq. cm., an average expansion of 1.6 per cent, a true sp. gr. of 2.4, an apparent sp. gr. of 1.9, and a fusion point of about 1, 80° C. The bricks have been used for lining a Martin furnace; they have already withstood 200 heats and it is expected that they will withstand more than 300 heats. They are also employed satisfactorily in a number of forges, replacing aluminous bricks.—Note from *Jour. Soc. Chem. Ind.* on an article by Philippon in *Comptes Rend.*

Photos by The Gilliams Service

A typical sugar making camp where the sap is boiled down

Boiling down the sap in the open in a large, shallow pan

The Maple Tree Helps to Relieve Sugar Shortage

An Old-Time Industry Neglected of Late

In New England and Canadian forests more maple trees have been tapped this spring to give up their saccharine wealth than for years, and there are now many indications that the original American sugar industry will take on new life in effort to make up cane and beet sugar shortage due to war.

Up in the woods of Vermont and of some of our other New England states and in the forests of the vast Dominion to the north of us large gangs of men have been exceedingly busy this spring doing their bit towards increasing our sugar supply which was very badly depleted a few months ago because of increased war demands and difficulties of transportation.

This work after all is only getting back to first principles as the maple trees of our northern woodlands furnished the original American sugar and were once, in fact, our only source of saccharine supply.

When this nation was young we were able, thanks to maple sugar, for many years to get along very well indeed without the use of the foreign sweets, indeed sugar from cane was at one time as scarce in this country as it was in the Europe of the Middle Ages and that was scarce indeed as it was dealt out in scruples and drachms by the apothecary.

Cane sugar, on which we think we are so dependent, is after all only a modern interpolation. The culture of the mammoth grass from which it is derived was not introduced into the United States until 1794 and even now, although we consume enormous quantities of cane sugar, there is no very great amount of sugar cane cultivated within the actual borders of this nation.

The Indians were the discoverers of maple sugar, and were making considerable quantities of it when the early settlers reached the New World. They had rather crude methods for the gathering of the sap and the evaporation of the fluid, yet they produced much good sugar. The white man improved the kettles and the process of sugaring off and increased the supply.

For a time after the pioneers began to develop the sugar industry it seems as though the maple sweet was firmly established among us, and many thousands of acres, both in the United States and Canada, which adopted the maple leaf as its emblem, were gradually placed under cultivation and every year for some weeks in the early spring the maple forests were alive with the sugar makers.

Not only was maple sugar manufactured at one time in large quantities in the New England states, but New York, Pennsylvania and the middle western states also once abounded in sugar groves.

Then came the extensive introduction of cane sugar in our market and our own domestic maple sugar industry took a slump until this sugar became so scarce as to be almost a luxury in recent years.

To fully illustrate the mighty nature of the industry at the height of its prosperity, in the year 1859, 52,900,000 pounds of maple sugar were manufactured in this country. Although the population of the United States has vastly increased since this banner year the production of maple sugar, because of decreased demands, has been cut to half its former proportions.

The last time the Department of Agriculture made a survey of the industry of sap boiling was in 1910, when there were 14,000,000 pounds of sugar sold and 4,196,000 gallons of the syrup produced.

Throughout the middle west, well east of Chicago, are the old-time woods of the maple which were planted and tended by our ancestors or brought up from stands of tender saplings. Many of those groves, when the maple sugar industry declined, were converted into picnic resorts by the original owners or by railroad companies or camp meeting associations which acquired them. Only a ghost of its old self is the once lordly clump at Sugar Grove, Ohio, a town

Tapping sugar maple trees and hanging buckets on the inserted spouts

formerly famed for its sugar through all the country round about, and far into the east, and once the rival of Vermont.

Although our ancestors practically used maple sugar for all sweetening purposes, Americans today eat less than half a pound a year apiece of it as compared with the eighty-six pounds of cane sugar which represents their per capita consumption.

With the beginning of the European war the price of maple sugar, scarce as it was, was not much more than that of the cane product, for so small was the demand it could be bought at eight cents a pound wholesale. The following year it was selling at 15 cents, while at present what remains of last year's stock on the market is bringing twenty cents at wholesale, or from thirty to thirty-five cents at retail. What the new and greatly increased crop will sell at it is difficult to say, which seems to indicate we are again beginning to appreciate maple sugar.

Certain it is that even with cane sugar held down by Government regulation to a retail price of eleven cents, there are many inducements which have caused those who still own sugar groves to bestir themselves this season. And that is why more maple trees have been tapped this spring and have given up their saccharine wealth than for years and years. Altogether there are at present many indications that the war may cause a recrudescence of the once very promising maple sugar industry.

Of all our states which once were rated as maple sugar producers in only five is this old-time sweetening now made, Vermont, New York, Pennsylvania, Ohio and Indiana; and of these five only Vermont really cuts any ice, or in other words has in any way held her own against the inroads of cane and beet sugar.

That the Green Mountain state is doing this fairly well is shown by the fact that in the years of 1913, 1914, 1915 she tapped annually 5,000,000 trees with 4,700,000 available, but not tapped until this season. In each of the years mentioned the sugar amounted to more than 7,000,000 pounds and the production of syrup was 500,000 gallons, or the equivalent of 4,000,000 pounds. Apart from the need of an increased supply of sugar, there are a good many reasons why we should again turn our attention to maple sugar production in earnest. Not the last of these is its very popular and delicious flavor when properly prepared.

It has a pervasive taste which is easily imparted to other sugars with which it was formerly blended without notice and sold as pure maple sugar, before the pure food law required a frank declaration of the admixture. It has always been, and perhaps always will be, highly prized by those who are fond of griddle cakes, or crave choice confections made from this prince of the sugars.

There are some uncertainties, principally due to early spring weather conditions, connected with the gathering of a maple sugar crop; but the prevailing prices are so high that risks are well worth taking. The tapping of the maple trees—that is, of the common black sugar maple, which is the best for sugar, and of the red and silver varieties—begins late in February in the southern reaches and early in March in the northern woods. The time for the actual running out of the sap varies according to the season. If it is cold it may not begin to run well until April. Whenever there is a good thaw to break up the thrill of winter, however, there is activity about the sugar groves.

Freeze at night, thaw by day. That is when the sap runs freely. That is when the "sugar lot" teems with life and activity; when seasoned cordwood, replenished year by year for the purpose, is fed to the saphouse fires.

The sugar making season lasts from four to six weeks, according to weather conditions, and the average yield of sugar is about 4 pounds for each tree, although many trees will greatly exceed this amount.

From 4 to 6 gallons of sap are required to produce one pound of sugar.

To begin gathering his crop the sugar farmer bores a hole in the tree trunk with a three-eighths or half-inch auger, a wooden spout is then inserted, to which is attached a covered bucket, and the tree does the rest. The sap, which is clear and colorless, flows freely if the conditions are favorable, or in other words if it is mild enough, during the day, and after that the process in the big sugar camps is simple.

Men and boys go around and watch the buckets every now and then, and as soon as they are filled, the contents are poured into tanks which are drawn about the groves either on wheels or sledges.

Arriving at the crude refinery the sap is run into long, shallow pans to undergo evaporation with the aid of a little fire, and then comes the final boiling in the sugar shanty for reduction to a syrup, or the "sugaring off," which will produce dark crystalline cakes.

If the density is greater, the sugar will separate from the syrup. To make sugar, evaporation may be continued until it boils at 23° F. The syrup is then stirred while cooling or placed in moulds to harden. The best way to make sugar is to make syrup, draw off, allow to cool and settle, strain and continue the concentration.

Evaporators vary much in size. Some sugar makers boil their sap in single-section vats on their cooking stoves. Others use open kettles out-of-doors. As a rule, the more modern the equipment the better the sugar or syrup. The best quality of maple sugar is 97.6 per cent. pure.

There is no standard water content for maple sugar, but there is for syrup—32 per cent.

There is a wide variation in the percentage of sugar in sap. Some trees yield but little, especially those with few branches and slight exposure to the sun. Those with many branches and sufficient exposure to light give plentifully. The average tree will yield about three pounds of sugar, the sap being about three and five-tenths per cent. sugar. Indiana and Ohio sugar and syrup are lighter in color than the maple products of Pennsylvania, New York, Vermont, and eastern Canada, and therefore are less readily diluted and adulterated. New York and Canadian products are strong and dark, and are preferable for mixing with other sweets to make the cheaper brands of syrup. The Vermont sugar is mild, delicate and richly flavored.

The brown tinge of maple sugar, which some incorrectly think is due to the color of the sap, is partly attributable to impurities such as may come from pieces of bark, but the color which is so characteristic is in reality mainly from the caramel developed in the kettles. The scorching of even a small amount of the contents of an open kettle produces the burnt sugar hue such as we see in the raw or brown cane sugars of trade.

Since our tastes have been cultivated to demand white sugar some efforts have been made, from time to time, to produce a perfectly white crystal from the maple syrup, such as is derived by elaborate vacuum pan refining processes from the cane; and while it is believed to be quite possible to do this, it has not been accomplished, largely on account of the low price at which it was possible to put the tropical product on the market before the war, and also because we have become so accustomed to brown maple sugar that if it was offered to us white we might be suspicious of its purity.

The Indians, as did the pioneers, used maple sugar much as we do salt at present. They rubbed it on their meat both as preservative and seasoning. They stored it in cool caves against the coming winter, and drew upon the reserves throughout the summer. They even built up a trade in it.

The maple sugar harvest for this year, estimated on the yields of the last three years, should be three and a half to four million dollars, and the syrup will more than double that amount; in other words, our maple trees, restricted as their yield has become, will add to the nation's income between ten and twelve millions.

Collecting maple sap in a tank drawn through the woods on a sledge

The Weight of Spanish Cedar

By C. D. Mell

The question as to the weight of the wood of Spanish or cigar-box cedar (*Cedrela odorata*) has been raised from time to time by transportation companies. Ocean steamship companies accept cargoes of round cedar logs at a rate based on a thousand feet board measure as determined by the one-fifth or the Scribner-Doyle rule. In the case of squared logs these rules do not apply and the weight is then generally computed from the actual contents measurement by multiplying the number of cubic feet by the weight per cubic foot. Transportation companies have not yet agreed upon a figure representing a fair average weight per cubic foot of well-seasoned, squared Spanish cedar logs from any specified region. It is generally conceded, however, that the cedar of Cuban and Haitian origin is heavier than that from the lowlands of Mexico and Central America. Even the Brazilian cedar which is regarded by many to be botanically distinct from the well-known West Indian kind is reputed to be heavier than that from Central America. The Brazilian wood is gummy and less apt to season so quickly and completely as the Central American kind. Moreover, many of the logs of Central American origin are cut and squared from dead and down timber which is perfectly dry and not so heavy as the wood cut from live trees. Without any specific figures it is safe to say that Mexican and Central American cedar is somewhat lighter in weight than that from other sources. While there are a good many published figures on the weight of cedar from all sources, the data dealing with the condition of the samples tested are in most instances wanting, which renders the value of such figures for certain calculations rather doubtful. However, the figures given below have been selected from authoritative works and it is believed that they represent a fair average.

The following is a list of weights per cubic foot of Spanish cedar with reference to the authorities:

Weight in pounds per cubic foot.	*Authorities.*
27.43[1]	Laslett, T.: Timber and Timber Trees. London, 1875, p. 269.
27.5	Semler, H.: Tropische und nordamerikanische Waldwirtschaft und Holzkunde. Berlin, 1888, p. 719.
30.0	Mell, C. D.: Trees of Porto Rico. U. S. Forest Service Bull. No. 354, p. 78.
27.5	Stone, Herbert: The Timber of Commerce. Lon-
39.5	don, 1914, p. 36.
28.1	Sandoval, Aurelio, Civil Engineer, University of Havana: Resistencia, Elasticidad y Densidad de las Principales Mederas de Cuba y de las Importadas de los Estados Unidos. A leaflet published in Havana, Nov., 1903.
37.0	Baterden, J. R.: Timber. London, 1908, p. 145.
43.0[2]	
28.8	Cook, O. F., and Collins, G. N.: Economic Plants of Porto Rico. Contributions from U. S. Nat. Herbarium, Vol. VIII, pt. 2, p. 110.
27.0	Boulger, G. S.: Wood. London, 1908, p. 160.
47.0[3]	
37.2	Correa, M. Pio: Flora do Brazil. Rio de Janeiro, 1909.
35.9[4]	Fowke, Capt. Francis: Reports from Commissioners, Paris Universal Exposition, Vol. XXXVI (19), pt. 1, 1856, p. 447.
36.0	Rea, John T., Surveyor, War Department: West Indian Timbers. Imperial Institute Journal, London, Vol. VIII, No. 93, Sept., 1902, p. 241.
33.43— Average.	

[1] The average of six samples.

[2] This refers to Cedar of Brazilian origin which is gummy and heavier than that from Central America.

[3] Herbert Stone, one of the best English authorities on wood, considers the figures given by Boulger mutually contradictory.

[4] This figure obtains for Jamaican Cedar.

Sea Gulls as Scavengers

As a sea scavenger, the California gull is well known, but few people realize that this bird is an accomplished inland scavenger as well. Not only do gulls clean up refuse, garbage, dead fish and offal on land and water, but they also render important service to agriculturists by destroying insect and rodent pests. In 1907-08 they deserted their haunts on the Great Salt Lake to rid the Nevada alfalfa fields of field mice which threatened to destroy the crops. They lived in the alfalfa fields and in the adjoining fields until they had completed the work. Many years ago they rendered a like service to the state of Utah, through the destruction of grasshoppers which were laying waste the Utah grain fields. In remembrance of this service the people of Utah have erected a monument to the sea gulls, at a cost of $40,000, in one of the parks of Salt Lake City.

Several years ago, when the Oakland city garbage was dumped in the ocean outside the heads, large quantities of this waste were washed ashore. Were it not for the gulls this would have caused a great nuisance along the beaches, but these efficient birds kept the beaches clean.

When the large suction dredgers began operations on the east bay shore near Oakland, in the reclamation of hundreds of acres of tide lands, large quantities of mussels and clams were brought up. The dredgers had hardly begun their work before sea gulls in large numbers appeared. How these birds learned of the new food supply that was being sucked up from the bottom of the bay, none can tell. They swarmed about the outlet pipe by hundreds, scrambling for the clams and mussels that were poured out with the mud, sand and water. Since the beak of sea gulls is not designed for crushing purposes, they were unable to break the hard clam shells. The birds are very resourceful, however, and they were observed flying to a height of thirty or forty feet, dropping the clams on the rocks until the shells were broken. One bird was seen to thus drop a clam fifteen times before breaking the shell.

At the last Christmas bird census under the auspices of the National Audubon Society, local observers in San Francisco between the hours of 8.30 A. M. and 6.00 P. M. noted 15,000 gulls from Golden Gate Park to Lake Merced, a distance of less than three miles. This gives an indication of the large numbers of these scavengers on our coasts, and since ten of them are equal to a pig, according to Wm. L. Finley, the Pacific Coast ornithologist, it is obvious that our beaches, waterfronts and bay shores would be in filthy condition were it not for the gulls.

There is plenty of waste material for these birds, without resorting to the philanthropic work of feeding them from the ferry boats. Some people, in these days of food conservation, make a practice of filling their pockets with bread, which they throw to the gulls. It is enjoyable to watch these perfect aviators swoop down upon a choice morsel of bread, but it is not in accordance with the food-saving requirements of-today.

There has been some discussion relative to the gathering of sea birds' eggs for the market, because of the high price of hen's eggs. While the eggs of sea birds are said to be palatable, to gather them for commercial purposes would undoubtedly result in the extermination of gulls. —*Bulletin of the California State Board of Health.*

Limiting the Rule of Kings

"At a certain stage of social evolution," says Sir James Frazer in his article entitled "The Killing of the Khazar Kings," in the December (1917) issue of *Folklore*, "not a few races appear to have been in the habit of putting their kings to death, either at the end of a fixed term, or on the failure of the king's health and strength, or simply whenever a great public calamity, such as drought or famine, had befallen the country." Among tribes which have practised this remarkable form of limited monarchy must now be included the Khazars, or Khozars. For some 900 years this now almost forgotten tribe, from their home in the spurs of the Caucasus and along the western shore of the Caspian—called after them the Sea of the Khazars—played a great part in history on the European-Asian borderland. It is certainly remarkable that a people which had reached such a high level of civilization and culture should have practised legalized regicide. But the evidence collected by Sir James Frazer from a very wide survey of medieval literature leaves no doubt on the matter. This survey of an almost unknown tribe is a contribution to anthropology of permanent value.—*Nature.*

Problems of Atomic Structure—III*

Defferences Characteristic of Different Elements, and Mechanism of the Molecule

By Sir J. J. Thomson

[Continued from Scientific American Supplement No. 2211, Page 307, May 18, 1918]

In commencing his discourse, the lecturer said that on the last occasion he had considered the question of the equilibrium of a number of electrons surrounding a positive charge, when the latter was assumed to be concentrated at a point. If the forces between the charges followed the ordinary law of varying as to inverse square of the distance, stable equilibrium would be impossible, though it became possible if the electrons rotated round the positive charge, or if at very small distances the law of the force was not that of the inverse square. He had assumed that in such cases the law was given by the relation,

$$\text{Effective force} = \frac{Ee}{r^2} - \frac{h^2}{r^3} \quad . \quad . \quad (1)$$

It was, in short, not possible to build up a theory of the structure of the atom, merely from the assumption of point charges acting on each other according to the inverse square law, even although it was possible, as already stated, to secure stable equilibrium by setting the electrons in rotation. The difficulty which arose was that with equilibrium thus secured the radius of the orbit might be anything, whilst to account for the observed properties of the atom, the distances of the electrons from the center must be sharply and definitely grouped at particular radii. It was necessary accordingly to introduce some other consideration than that of the equilibrium being maintained by the rotation of the electrons round the central charge under the influence of forces varying according to the law of the inverse square. The hypothesis that developed in the simplest way was represented by equation (1) *supra*, which included a term representing repulsion varying as the inverse cube of the distance between an electron

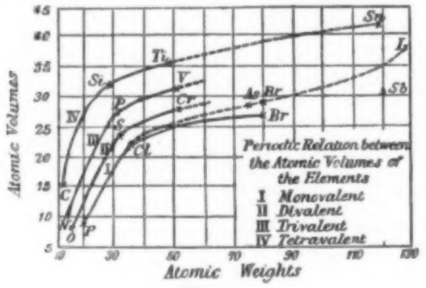


Fig. 1

and the positive charge. At very small distances the electron was accordingly repelled from the positive charge, at greater distances it was attracted, and it settled down accordingly into a position of equilibrium.

The hydrogen atom was regarded as having but one electron and one positive charge situated at the center of the atom. An atom containing two electrons would have these located symmetrically at opposite sides of the center and a little closer to this center than when only one electron was present. Three electrons would occupy the corners of a triangle, and would be still closer to the central charge. Four electrons would occupy the corners of a tetrahedron, and would again be closer to the center than the three. In short, as more and more electrons entered into the atom, the size of the latter shrank, each addition of an electron making the position of equilibrium closer to the center. This rule held until the total number of electrons amounted to eight. If a ninth were then added, this would not join the group of eight which occupied the corners of a twisted cube, but would form a sort of detached satellite much further out. If a tenth were added, this also would remain outside the central group and, thus, by adding further electrons a second shell would be built up which again, however, could not contain more than eight electrons. The addition of a seventeenth would, in fact, start a third shell.

It would be seen that as the number of electrons was increased the atom passed through several stages. Beginning with one, the number could be progressively increased to eight, but the addition of a ninth started a new series, so that in all cases the outer layer of electrons never contained more than eight. This peculiarity recalled the periodic law in chemistry. If we imagined that the number of electrons increased with an increase of atomic weight, then the element corresponding to an inner shell of eight electrons, with one electron in an outer shell, would be lithium. As the atomic weight was increased more and more electrons would be added to this outer shell, but when the number reached eight the addition of another would start a third shell, in which, as in the case of lithium, there would be only one electron in the outermost layer.

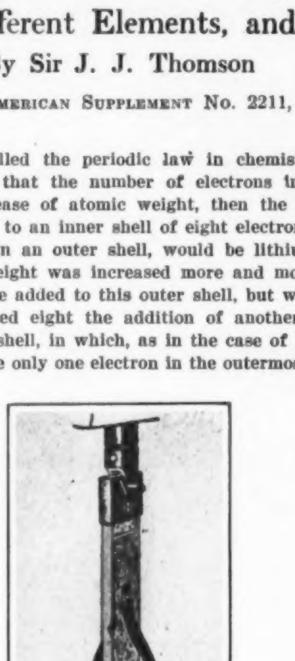


Fig. 2

We then got sodium, with properties very analogous to those of lithium. Adding eight more electrons, a fourth shell was commenced, having again but one electron on the periphery of the atom, and we thus got to potassium. It would be seen that the structure which arose from the assumption represented by equation (1) gave a kind of reproduction of Mendeleef's periodic law, and he proposed to develop some consequences of supposing that the number of electrons in the outside layer was equal to the positive valencies of the atom, whilst the negative valencies were equal to eight minus the number of positive valencies.

Suppose that the atoms were built up by the law assumed above, how would the size of the outer layer alter with the atomic weight? If the repulsion were constant, as the number of electrons increased from one to eight, the layer would get nearer and nearer the center of the atom. Hence, although, as he had observed last time, the atomic volume was a slightly indefinite term, this atomic volume would shrink too. If the assumed law were right, therefore, we should expect that, as we proceeded in a chemical series from mono-valent to di-valent, and from di-valent to tri-valent atoms, then the atomic volume should diminish, since the outer layer of electrons shrank nearer and nearer in toward the center with each increase in the valency. With but one layer and eight electrons in it, we got neon, which was followed by sodium, with which a new shell was started having but one electron in the outer ring. In this atom the positive charge was shielded by the inner layers of electrons, and was thus equivalent to but a single positive charge. The net electric force would thus be the same as before, and on starting the new outside layer with one electron there would be a sudden increase in the radius of the atom. If the assumed repulsion were independent of the total positive charge present, this radius for sodium would be exactly the same as that for lithium, and these two elements would have accordingly the same atomic volume.

It would be seen that, if we confined ourselves to one series of elements the atomic volume should, on the theory expressed by equation (1), diminish as we proceeded along each chemical series, and it should jump up on entering the next series.

Lately much attention has been paid to the study of atomic volumes, and Fig. 1 represented the results arrived at by Mr. Lebas. These were deduced from a study of the hydrocarbons, and included, therefore, only such elements as combined with carbon. It would be seen from the curves drawn that the atomic volume diminished as we passed from silicon to phosphorus, sulphur and chlorine, and was smallest with the latter electro-negative element at the end of the series. In the first set, again, Mr. Lebas did not confirm Lothar Meyer's minimum at carbon, but found that the atomic volume diminished as he passed from carbon to oxygen, which was represented in the diagram as having a smaller atomic volume even than fluorine. There was, however, some little doubt as to whether this was really the case. Apart from this doubtful exception, the diagram showed that in each chemical series the atomic volume steadily diminished as the positive valency increased, and then jumped up again at the start of a new series.

The view put forward above had been suggested by a study of Mr. Lebas's diagram. One point arose of critical importance. We should expect when we passed into a new series with one electron in the outer layer that if the radius of this layer were the same as at the start of the preceding series, the properties of the two atoms would be identical. On the view in question, the electron population in the outer layer was always scanty. With one electron in an outer layer and eight in an inner layer the diameter of the outer ring was five times that of the inner shell. It would be necessary, therefore, to go much more than half way through an atom to reach the inner layer, and a single outer electron was thus very isolated. If, therefore, such an isolated electron was situated at the same distance from the center as the corresponding electron of the element at the start of the preceding series, we should expect that the properties of the two elements to be almost identical. We knew, indeed, that they were similar, but they were by no means identical. The point that arose was what was the origin of this difference in systems containing the same number of electrons in the outside layer. This introduced a point of very great importance as to the mechanism at work.

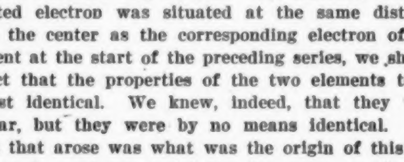


Fig. 3

In the foregoing it had been assumed that the repulsive force on the electron was independent of the gross amount of the positive charge present, so that an increase in the amount of positive electricity at the center did not increase the repulsion on a single electron in the outer layer. As the repulsion depended upon the positive charge, this assumption represented a rather unlikely state of affairs, and it appeared more probable that as the positive charge at the center increased so did the repulsive force. If that were so, the repulsion on a single electron in an outer layer would be greater when there were inner shells of electrons than in the contrary case. Its position of equilibrium would therefore be further away from the center of the atom, and the new system with an additional inner shell would not be a mere repetition of a previous system. We could thus pass from the series headed by lithium to the sodium series, and in each successive series the size of the atom would be greater than that of the corresponding atom in the previous series. This conclusion agreed with observation, sodium having a greater atomic volume than lithium, and potassium than sodium.

One of the strongest arguments in favor of the view that positive and negative charges of electricity formed the structure of bodies was provided by Curie's discovery of piezo-electricity. Curie found that the mere deformation of certain crystals by stress electrified them, the charge being positive in certain regions and negative at others. It was not every crystal which showed the effect, which was, in fact, confined to forms characterized by a certain lack of symmetry. Quartz and tourmaline, however, were both effective. Slices cut from tourmaline perpendicular to the axis, which was always clearly defined by certain streaks parallel to it, became electrified if subjected to pressure. With the cheaper kinds of tourmaline the effect could not be observed owing to the high conductivity of these cheaper qualities, but transparent tourmaline showed

*A paper presented at the annual meeting of the Society of Automotive Engineers, and published in the Journal of the Society.

it well. With quartz there was also trouble in getting satisfactory specimens. Quartz had an inveterate habit of twinning, with the result that charges of opposite sign were developed close together on the same face, thus neutralizing each other. Nevertheless, slices of quartz could be obtained which showed the effect well, and Curie had used extensively, in his laboratory, the arrangement shown in Fig. 2. Here a slice of quartz, suitably cut, was arranged so that it could be put under tension. The faces were silvered, one face being connected to an electrometer and the other to earth. By varying the pull on the quartz, a charge given to the electrometer from some other source could be neutralized, and the arrangement was a very convenient one for "null" methods of electrometry as, with practice, the spot of light could be kept steadily to zero by suitably adjusting the tension on the quartz. Tourmaline could not be used in the same way, but could be used to measure hydraulic pressures by the electrification developed when it was exposed to them. In this case quartz would not answer.

Recurring to equation (1), the lecturer said that it was useful to form some definite idea as to the origin of the repulsion represented by the second term. As an aid to specifying its nature as clearly as possible, it was convenient to regard it as due to something which he would call particles, but he did this merely for facilitating brevity of statement and for simplicity in reasoning. The word particle was, in short, to be taken in a Pickwickian sense, and he did not assume that these particles had mass or any other property than that of acting as a repellent. On this assumption the atom would consist of positive and negative electrons plus these particles, or units of repulsion, and in view of their purely hypothetical nature he would denote them by q ?.

Taking the simplest case, that of the hydrogen atom, if this consisted merely of one electron and one charge of positive electricity, it might be supposed that with this simple structure the behavior of the atom would also be simple and have a simple spectrum. On this simple view it was difficult to explain how the actually very complicated spectrum of hydrogen was produced by the possible vibrations of the electron. Hydrogen gave, in fact, two spectra. The one contained a number of widely separated lines forming a series obeying Balmer's law. There was also a second spectrum which was full of lines, particularly in the region of the red. A portion of this second spectrum was represented in Fig. 3.

It would appear to be a formidable task to attempt to explain the existence of all these lines if we started merely with a single electron vibrating about its position of equilibrium. It reminded one of the old lines:

. . . "Still the wonder grew,
That one small head could carry all he knew."

If, however, the atom contained also these hypothetical repelling particles, there might be more of these associated with the central charge in some hydrogen atoms than in others. It was the repulsion which kept off the electron from the center, and if the number of repellent particles varied we should get a series of hydrogen atoms of different sizes.

Suppose any one of these atoms was suddenly deprived of one of these units of repulsion. The electron would then jump closer in and settle down into a new orbit. It was, in his opinion, an hypothesis, deserving of further test, that the origin of the spectrum was to be attributed to the ejection of one of these repellent particles from the central core. The atom was previously in a steady state with its electron at a certain distance from the center. On the ejection of a repellent particle this electron would now fall in and form a new atom radiating on the energy as it settled in its new position of equilibrium.

There was, he thought, a good deal to be said for supposing that in some way such as this the radiation of the atom was to be accounted for.

Dr. Bohr's theory of the origin of the spectrum held a considerable resemblance to the foregoing. Bohr regarded the spectrum as arising from the passage of hydrogen from one kind of atom to another kind of hydrogen atom. He introduced the idea that the moment of momentum of the electron circulating round the central charge suddenly jumped and changed by a unit. It was during this change that Bohr considered the radiation to take place. There was, as stated, a resemblance between this view and that put forward *supra*. The speaker, however, found a difficulty in following out how the radiation arose on Bohr's hypothesis, although it must be acknowledged that the results of Bohr's calculations were in striking agreement with experiment. For his own part, he got clearer ideas in imagining that the ejection of one of his hypothetical particles from the central core was responsible for the radiation of the atom. On this view there should be many kinds of hydrogen atoms varying with the number of the particles in the core.

It would be interesting to get direct evidence of the existence of these different kinds of hydrogen atoms. The spectroscopic evidence was insufficient. The only plan of attack available would seem to consist in measuring the energy needed to ionize the hydrogen atoms, that was to say, the energy required to tear out an electron. If this electron were a long way from the center, less energy would be required than if it were closer in. Some measurements had been made, and there did seem to be indications of several stages of ionization. Thus one stage was attained with 11 volts, and there was another stage which required 15 volts. He would not press the matter or say that a difference in the hydrogen atoms was the only possible interpretation of these results.

[TO BE CONTINUED]

Tree Planting for Forests*

By Shirley W. Allen

Simply because forests form one of the most important of the renewable type of natural resources, the matter of creating forests or re-creating forests on new areas or of reproducing them where they now occur is a serious and timely economic problem. War taxes make it more than ever necessary that there shall be no idle acres, and this applies to non-agricultural land too. Nature has a way of doing things with a rather wasteful hand and her method of forest reproduction by scattering enormous quantities of seed from parent trees, is a difficult matter for man to duplicate. This is because the cost of seed is all out of proportion with the success which he can expect from broadcast sowing in the place where he expects the forest to stand eventually. On the other hand he can improve on nature's method by sowing a smaller amount of seed in a place where it can be guarded when soil conditions are better, and where the resulting plants may be so cared for that there is a small natural loss. In other words, he can give the trees a start in a forest nursery. Subsequently, when the plants become sufficiently vigorous, he can transplant them into the forest or in open country better adapted to the growing of timber than to agricultural crops.

If he has properly determined the quality of the "site" as foresters say, and the adaptability of the species he is using, and if he has provided for protection from fire and other enemies, he may expect to produce a forest. In other words, the business of planting trees for forests is surrounded with just about the possibilities for success or failure that we find in raising of a crop which matures in a shorter time.

Attempts to raise forests with broadcast sowing of tree seed occurred in this country as early as 1906 in the neighborhood of the Black Hills and throughout other parts of the Dakotas, and in the fall of 1910 an enormous area of burned-over land in the Western National Forest was seeded at the request of James S. Wilson, who was then Secretary of Agriculture, and who as Secretary had control of the National Forests. Men in the Forest Service at that time did not approve of this experiment but were willing to give it a thorough trial under as many conditions as could be secured. The success attained was extremely slight and not sufficient to make this a general method.

Raising the nursery stock, however, has been more successful and there are now numerous Forest Service nurseries located throughout the West, where stock is being raised for planting on burned-over areas and other available planting sites on National Forests. A number of the state organizations have also taken up the growing of nursery stock to a certain extent for the purpose of reforesting barren state-owned land, but to a greater extent with the idea of furnishing well-grown nursery trees to owners of private holdings which are in need of reforestation.

New York State is foremost among the states in the Union in the production of forest nursery stock and has probably done as much planting on its State Forest Preserve as any other state in the Union. There are something over 7,000 acres of state plantations and more than 20,000 acres of private ones. Fast-growing conifers are the most widely used trees for the reason that coniferous timber is more in demand and easier to grow on short rotation. During the past year the five nurseries operated by the State Conservation Commission in New York State produced more than 8,000,000 trees.

It is not an easy thing to say just when a crop of planted trees will be ready to cut at a good profit. In searching for actual data on such questions we must take the experience of European foresters, discounting it in order to provide for the difference in site and other factors, or we must make measurements on the few early plantations which are scattered over the country, mostly in very small tracts and on plantings in the form of wind-breaks, or shelter-belts which are quite common throughout the United States.

Some conifers which are fast growing and are recommended for planting throughout the East are red pine, Scotch pine and Norway spruce. Among the hardwoods which are recommended for planting are red oak, white ash, green ash, Carolina poplar, black locust and basswood.

In the last few years one of the best trees for planting, the white pine, has been attacked by the white pine blister rust, a destructive disease which came to us from the domain of "Kultur" some years ago. Vast amounts of money have been spent in an endeavor to control this disease by means of destroying the species of *Ribes* upon which the disease lives during the imperfect stage. Many workers on this control problem believe that the white pine is doomed because of the excessive cost and difficulty of securing thorough work in the destruction of this temporary host.

The operation of planting is extremely simple and cheapness and efficiency is dependent as in anything else, upon good organization. A planting crew may be as small as two men in numbers; one to go ahead with a grub hoe or mattock to dig holes and the other to follow with the trees which he plants just as one would plant a tomato or a cabbage plant, except that no water is used. It is necessary, however, to keep the roots of coniferous trees moist because even the slightest amount of drying will cause the resin in the roots to harden and discount the chances of the little trees. Two good men can plant an acre a day. This means putting in 1,210 trees when spaced six by six feet. Close spacing is desirable, because the trees crowd in early life and the competition for light thus brought about stimulates height growth and at the same time makes a smaller number of knots per unit of length in the log which is finally produced. The crowding also brings about what we call natural pruning by shading out the lower branches and making it possible for clear logs to be produced.

The initial cost of establishing a plantation should not exceed $15.00 per acre, including the cost of the land, if good interest is to be expected.

Where it is possible to thin out a plantation at a profit such as might be the case in a stand of black locust where small fence posts could be secured, or in an evergreen plantation where hop poles might be a salable product, the thinning should almost take care of the cost of the operation and may even help to pay the taxes. Bucket stock may be secured from a pine plantation in as short a time as twenty-five years and a good quality of box lumber will result in forty years.

Forest planting will probably never be widely practiced on private land in this country until a more equitable system of taxation is adopted than the one in use at present. Various methods have been suggested, but there is a general feeling that the one recommended by Professor F. R. Fairchild, of Yale, based upon taxing the yield at the time of cutting, is the soundest system. Public sentiment has a long course of development ahead of it before private owners will do any great amount of planting, for the simple reason that the general attitude of property owners follows very closely the expression of a certain old farmer. This man in reply to a forester who urged him to plant idle land on his farm said, "What has posterity ever done for me?" On the other hand, the state and government can go ahead with this business, producing along with their forests a demonstration of the idea that planting trees for forests *is* good business.

* *Journal of The N. Y. Botanical Garden.*

New Vegetable Dye from Corea

As the result of investigations conducted at the Central Laboratory of the Government-General, it is stated that the dye "Shinnamu," obtained from the leaves of a species of maple tree, has attracted attention. In the vicinity of Kaijo (Song-do) a large quantity of leaves is available and the manufacture of the dye on an adequate scale is being planned. Also there has been experimental planting of the species of the maple tree referred to, which is peculiar to Corea, being found nearly everywhere in that country.—*Jour. Soc. of Chem. Industry.*

Starting to make a Panama hat

The hat half done

Putting on the finishing touch

Panama Hats

The Chief Industry of Southwestern Porto Rico

By Theodoor de Booy

It is a little-known fact that the entire southwestern portion of the island of Porto Rico is devoted almost exclusively to the manufacture of hats which practically rival the far-famed "panama" hats in delicacy of texture and general usefulness. Whenever one thinks of Porto Rico and its exports, sugar, coffee and fruits immediately come to one's mind; while these products constitute the greater riches of the island, it is nevertheless a fact that the majority of the female inhabitants of the coastal district, extending from the town of Mayaguez on the western coast to the southward as far as Cabo Rojo which gives this region its name, depend upon the making of hats for their daily bread.

Climatic and geological conditions, and a lack of roads, have caused this industry to be about the only logical one to make life here possible. The soil is far from being of the same rich capacity as is the soil of other parts of the island. Scant rainfall also is responsible for the barren aspect of this coastal strip, and as a result vegetation is confined almost exclusively to cocoanut trees and to the varieties of palms which are such familiar sights in dry tropical countries. A road, of sorts, connects the villages and settlements which lie along the coast with the larger towns of the interior, but wheeled traffic finds but small encouragement in the condition of this highway, and a great deal of communication takes place by means of small sailing craft. In consequence the inhabitants of this isolated region have but little to do with the outside world and lead a somewhat self-dependent existence.

The more important of the settlements here is named Joyuda and consists of perhaps as many as eighty houses, mostly arranged in picturesque order along the main, and only, street which parallels the seashore. Viewed from the sea, Joyuda with its cocoanut trees, its huts made from local materials without the use of nails even, its sandy road and cream-colored beach, bears a striking resemblance to a Kanaka village in the South Seas and it would need no great flight of imagination to people the abodes with cannibals of fiercest mien. A few of the more pretentious houses conform in type to the ones generally seen in Latin-American countries, but the balance of the structures are distinct reminders of the former Indian inhabitants of Porto Rico, who left their *bohios* or huts as a legacy to posterity. Two wooden stores, a seldom-used wooden chapel and a small school are the only public buildings in Joyuda.

A visitor to this village will be struck by two things on his arrival. In the first place he will note that each dwelling seems to be filled with women and children who are busily working on hats in all stages of completion. In the second place, his ear will be astonished by a constantly occurring subdued high note, somewhat resembling the squeak of a mouse. Wherever the visitor goes, this sound will pursue him, until he at last notices that it is produced by the drawing of the strips of straw through the pleats of the unfinished hats. The friction occasions the sound, and a conversation between two hatmakers is interspersed with "cheep-cheeps" which form a strange mixture with the Castilian of the natives.

The abundant presence of a peculiar form of palm, generally from eight to ten feet in height, with a wide-spreading crown and upstanding fan-shaped leaves, is more directly responsible for the manufacture of hats.

Primitive huts where the hat makers live. The lower palms shown furnish the material for the hats

The young leaves of this palm provide the material which goes into the making of the head-coverings and, in consequence, have a market value which depends upon the fineness and the color of the dried leaf. The owners of land upon which this species of palms thrive —and it may incidentally be stated that this palm is not cultivated but is found growing wild—"gather" their crops by cutting one of every two green, unopened leaves from the stem of the tree, allowing the other leaf to come to the fan-like shape attained on its maturity. This method of conservation is practiced in order not to kill the palm by injudicious pruning as the latter process would not only destroy the tree, but would also prevent future propagation of other trees by means of the ripe seeds distributed by the flowering palm. The palm is of the self-pruning variety: in other words, whenever the leaves die and dry out, they detach themselves from the stem and fall to the ground. These dried leaves have also a commercial value, although a far smaller one than the young leaves used in hatmaking. The former are in demand for making the thatch of the native houses, and form an excellent covering which is unusually well adapted to the requirements of the climate and at all times provides a cool and an impenetrable roof. The leaves are also used for the walls of the huts, and, in fact, the entire dwelling is made from various parts of locally found palm trees.

The young leaves used for the hats are cut before they have opened and while they are still green. They are then opened out by hand and laid in the sun to dry, and to bleach and under the intense sun rays their original green quickly fades and becomes light cream-colored. After all the moisture has dried out of the leaves they are graded according to their color and the delicacy of their fiber, and sold to the hatmakers. Very fine leaves, of excellent texture and almost pure white in color, sell as high as 80 cents apiece, and it takes two of these leaves to produce the finer type of hat. The usual hat is made from the coarser, yellower leaves which have a value of about 15 cents, and from one of which two of the cheaper varieties of hats can generally be made.

For the making of hats the leaf is now split into thin strips, about one-sixteenth of an inch in width. The finer the hat, the narrower the strips are made, and the length of time necessary to weave a hat depends a great deal upon the width of the strips. The strips once made, they are tied in a bundle and the hatmaker is now ready to commence operations. It would be impossible for one unversed in the technique of weaving to describe accurately how the work is done. A visitor to Joyuda will first note one of the native girls with a bundle of palmleaf strips, and observe that she is joining some of the strips together in a seemingly aimless fashion. But if the visitor looks closely, after half an hour or so, he will see that the strips have been woven into a small disk which is to form the foundation of the top of the crown. From this disk hundreds of strips are pendant and these, in time, are shaped into the crown and brim. When the hat is finally completed, it presents a curious aspect. The strips which emerge from the brim and from where the crown is joined to the brim are tied together in small wisps and are generally not removed by the hatmaker but are cut off by the dealers when they put the finishing touches to the head-coverings. Occasionally the hatmaker will do

Mair street in Joyuda, the most important hat making town in Porto Rico

Beach and native house at Joyuda, Porto Rico

this work herself, when the hat is intended for local sale, and in that case the wisps are trimmed closely to the hat, and after being shaped by hand the hat becomes the pride of its purchaser.

The finest grades of hats occasionally take two months to complete. This is not only because the actual labor amounts to more than it does for the making of the ordinary hat, but because the operator can only work on the finer grades for a short while in the mornings. At this time the dew is still on the ground and the strips of palmleaf are still impregnated with the tropical humidity that penetrated them during the night. In consequence there is less danger of the fine strips breaking off or cracking during the weaving, owing to the greater pliability of the straw. After the heat of the day once sets in the straw becomes dry and is extremely liable to break in the operator's hands. This danger is not found with the coarser grades suitable for less expensive hats. Of these latter an expert weaver can turn out as many as two or three per week.

The hats once finished, they are bought regularly up by buyers sent out by the large hat dealers from Mayaguez. The buyers go from house to house in the native settlements and purchase the ordinary grades of hats for about 80 cents, while the finer grades occasionally sell as high as $40. These latter are rarely bought by dealers but are more generally ordered by private customers. A first-class Porto Rican hat, of the best workmanship and of white straw, weighs but an ounce or two and is a beautiful specimen of the weaver's art. But at the same time a hat of this class has to be handled with so much care, owing to the fact that the fine straws are brittle, that it becomes an expensive luxury. The ordinary grades, on the other hand, are extremely serviceable and stand any amount of folding and rough usage.

When the hats reach the wholesale dealers they are first of all trimmed and graded. After this the hats are subjected to a bleaching process in sulphur fumes which whitens the straw even more than the sun did. The hats are finally sorted according to price and size and packed for shipment to northern markets. The 80 cent Joyuda hat has now reached a retail dignity of $3.50, and is sold as a "genuine panama" to those unfamiliar with the fact that "panama" hats do not, *per se*, have to come from Panama, or even from anywhere near the isthmus. But as a matter of fact, the original Joyuda hat, before it has been subjected to elaborate shaping and bleaching processes, is a far more serviceable and durable article than is the hat that has passed through the hands of the Mayaguez hat dealers. The Porto Ricans of this region, and such foreigners as are familiar with the local hats, invariably prefer the more or less unfinished product to the hat that has been "improved" for northern requirements.

In addition to the making of hats, the natives of this district manufacture a peculiar type of woven basket, of various sizes and shapes. This latter industry has only lately developed, but the hat dealers have already given it a remarkable impetus by purchasing the baskets and exporting them to other countries. The baskets at first were only sold to tourists as a typical product of this section of the country, but are now in universal demand, and it is expected that the northern markets will take all that can be supplied. It has been stated that these baskets are a survival of the Indian basketry, made four hundred years ago on the island, and that the art had remained known in the mountains where the poorer class of Porto Ricans had been in the habit of weaving these containers for their personal uses. It would be hard to say if this statement is true, but it lies well within the bounds of possibility. On no other West Indian island are baskets made that resemble the Porto Rican product in the slightest. Neither do the Porto Rican baskets resemble the African types, so that the argument that this type was introduced by negroes in the days of slavery cannot be forwarded. But no matter whence the type came, the baskets are undeniably attractive, and it will probably not be long before they will be familiar sights to the inhabitants of the United States.

Odd Paintings By American Indian

The American Museum of Natural History has recently placed on exhibition in the tower room of the Plains Indians Hall two paintings by Short Bull, a famous chief of the Oglala Dakota (Sioux) Indians. Short Bull, who is now at the Pine Ridge Reservation in South Dakota, was one of the leaders in the "Ghost Dance outbreak" in 1893, when he fought in an engagement against the United States troops. His pictures in the American Museum, each of which is about six by two and one-half feet in size, illustrate the well-known "Sun Dance" as observed forty years ago.

The Sun Dance was a great annual religious ceremony which varied in purpose but was generally performed to promote the prosperity of the tribe. It was common to most of the tribes of the Plains. It took place usually about the beginning of summer, and with all the attendant ceremonies lasted more than a week, the dance proper continuing four days and nights. The entire tribe assembled for the occasion and pitched their tepees in a great circle in the center of which was erected the medicine lodge of leafy cottonwood saplings. The center pole of the lodge was decorated with streamers and painted symbols, besides which a sacred bundle—usually wrapped in a buffalo skin—was fastened near the top. The dancers were stripped and painted, and prohibited from eating or drinking during the four days of the dance. Their arms swung at their sides, and between their teeth they held whistles of eagle bone, on which they kept up a continual shrill whistling. On another side were drummers, who sang the songs of the sun dance to the accompaniment of a powerful drum. Many of the tribes incorporated torture features in the ceremony, these being incredibly cruel in some cases, although slight in others. The usual form of torture was to pass cords through slits in the skin of the victim—who was generally a volunteer—and with these cords either to suspend him from the sacred pole or have him drag buffalo skulls around the cottonwood enclosure. The entire ceremony included a rapid succession of performances and rites, such as feasting, giving of presents, addresses and initiation of new members into various societies. Owing to the torture features, the dance has been almost completely suppressed by the United States Government.

All the details of the dance are represented on Short Bull canvases—the great circle of tepees, each with its tribal decorations, enclosing the cottonwood lodge, the pole in the center, hung with streamers and surrounded by the dancers blowing their whistles, and suspended from the pole the voluntary victims of the torture. One of the pictures shows an Indian outside the circle dragging four buffalo skulls by the cords run through the loops cut in the skin of his back. The ceremony required that he continue to drag these until the skin was torn loose. In the center of this painting, suspended from the pole, are the figures of a man and a buffalo, drawn quite out of proportion, as is frequently the case in Indian art.

The paintings were collected by Dr. J. R. Walker, who represented the American Museum on a recent expedition. In the center of the Plains Indians Hall may be seen a model of an Arapaho sun dance, and in one of the Dakota cases objects used in the sun dance ceremonies are shown.

What Is Tonnage?

In reports on ship matters we frequently see statements in regard to the tonnage of ships that are apparently contradictory. This makes it difficult to get an idea of the actual size of the vessel, and especially to make comparisons with other ships. In an article in the April issue of *International Marine Engineering* an example is cited of a ship that displaced 15.000 tons, had a deadweight carrying capacity of 10,000 tons, a gross tonnage of 7000 and a net tonnage of 4500, and, with this as a text, it goes on to explain ship tonnage as follows:—

"Displacement and deadweight carrying capacity are measured in long tons of 2240 pounds; 2000 pounds is a short ton, and 2204 pounds, or the weight of a cubic meter of fresh water, is a metric ton.

"Gross and net tonnage are measured in tons of one hundred cubic feet of enclosed space in the ship. There are 44 cubic feet in a ton of coal, 40 cubic feet to the ton of package freight, and water occupies 35 cubic feet to the ton, so that this ton of 100 cubic feet needs explanation.

"In England in 1854, when the matter of tonnage was under discussion, it was found that the registered tonnage of the entire British merchant marine was 3,700,000 tons, according to the then existing measurement rules. The actual cubic contents was estimated at the same time to be 363,400,000 cubic feet. A ratio of 1 to 98. With the idea of keeping the registered tonnage about the same as it had been and at the same time simplify calculations, the gross ton was officially made 100 cubic feet of enclosed space. The United States adopted this measurement standard in 1864, and now it is universally used.

"Gross tonnage, then, is a measure of the enclosed space in the ship. Net tonnage is gross tonnage after certain deductions have been made of spaces which are not permanently enclosed or cannot be used for carrying cargo.

"Part of the enclosed spaces on a ship are supposed not to be used for carrying cargo, and are therefore deducted from the total or gross tonnage. The engine space, living quarters, bosuns' stores, etc., are such spaces. Steward's stores, refrigerating spaces, etc., are not deducted because they can be used for stowage of cargo.

"Most charges, such as canal tolls, pilotage, towing charges, etc., are based on net registered tonnage, so that it is not surprising that all the slick ones, the fellows who were bitten in the ear by a fox when they were very young, are trying to beat net registered tonnage. The more space that is exempted or deducted, the smaller this net tonnage and the less the taxes or charges against the operation of the ship. Spaces are exempted for purposes for which they are not used. Rooms for non-resident doctors, pursers and freight clerks may be used as storerooms.

The Art of Perpetuation*

Museums the Result of Man's Acquisitiveness

By Bruce Cummings

Just as the ancient hunter shot a fish with a spear, so we may imagine the ancient philosopher separated the Thing, caught it up out of the Heracleitean flux, and transfixed it with a name. With this first great preservative came the first great museum of language and logical thought. Ever since we have been feverishly busy collecting, recording, and preserving the universe or as much of it as is accessible. Perpetuation has become an all-absorbing art.

It is only recently that certain interesting, not to say remarkable, refinements in the technique of the art have been developed and come into common use, such being for example the museum, the printing press, the camera, the cinema film, the gramophone record. By the ancient Greeks and ancient Romans the desire to collect and above all to conserve the movable furniture of the earth was only indistinctly felt. As storehouses, museums were almost unknown. Small collections were made, but merely as the mementoes of a soldier's campaign, or a mariner's curiosities, like the gorilla skins brought home from Africa by Hanno.

The assembling of curiosities, drawing-room curios, bric-a-brac, and *objets de vertu* was still the immature purpose of the conservator even so late as the days of Sir Hans Sloane, Elias Ashmole, and John Hunter. Ashmole's gift to the University of Oxford was laconically described as "12 cartloads of curios." Hunter's museum, as everyone knows, was a gorgeous miscellany of stuffed birds, mammals, reptiles, fossils, plants, corals, shells, insects, bones, anatomical preparations, injected vascular preparations, preparations of hollow viscera, mercurial injections, injections in vermilion, minerals, coins, pictures, weapons, coats of mail. It is obvious that in those days the collector had not passed beyond the miscellany stage. According to his pleasure, he selected say a Japanese midzuire, a scarab of Rameses II, a porpentine's quill, a hair from the Grand Cham's beard, and saw the world as an inexhaustible Bagdad bazaar. Now he sees it as *exhaustible*, and is grimly determined to exhaust it as soon as may be.

To-day everything is changed. Mankind is astride of the globe from pole to pole like Arion on the dolphin's back. With all the departments of human knowledge clearly mapped out in the likeness of his own mind, man now occupies himself with collecting and filling in the details. He ransacks heaven and earth, armies of collectors brigaded under the different sciences and arts labor incessantly for the salvation of the globe. All objects are being named, labeled, and kept in museums, all the facts are being enshrined in the libraries of books. We are embarked on an amazing undertaking. A well-equipped modern expedition apparently leaves nothing behind in the territory traversed save its broad physical features, and as Mont Blanc or the Andes cannot be moved even by scientific Mahomets, the geologist's hammer deftly breaks off a chip, and the fragment is carried off in triumph to the cabinet as a sample.

It is estimated that there are about seven millions of distinct species of insects, and naturalists the world over have entered upon a solemn league and covenant to catch at least one specimen of every kind which shall be pinned and preserved in perpetuity for as long as one stone shall stand upon another in the kingdom of man. There are already an enormous number of such types, as they are professionally called, not only of insects, but of all classes of animals and plants jealously guarded and conserved by the zealous officials of the British Museum.

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When I was a small boy I greedily saved up the names of naval vessels, and inscribed each with a fair round hand in a MS. book specially kept for the purpose. Now the financial or æsthetic motives that may be said to govern the boy collector of postage stamps, birds' eggs, cigarette cards, must here be ruled out of court. For if half a dozen of the rarest unused surcharged Mauritius, a complete set of Wills's "Cathedrals" or Player's "Inventions," or a single blood alley of acknowledged virtue minister to the tingling acquisitiveness of the average schoolboy, it is difficult to say the same of the hunting down in newspapers and books of battleships, cruisers, and T. B. D.'s. At least I am inclined to think that my subconscious motive was a fear lest any of His Majesty's ships should be overlooked or lost, that it was indeed a good example of the instinct for simple conservation uncomplicated by the usual motives of the collector.

The joy of possession, the greed, vanity and self-aggrandizement of the collector proper, are deftly subverted to the use of the explorer and conservator of knowledge who, having a weak proprietorial sense—bloodless, anemic, it must seem to the enthusiastic connoisseur—is satisfied so long as somewhere by someone Things are securely saved. The purpose of the arch-conservator—his whole design and the rationale of his art—is to redeem, embalm, dry, cure, salt, pickle, pot every animal, vegetable, and mineral, every stage in the history of the universe from nebular gas or planetismals down to the latest and most insignificant event reported in the newspapers. He would like to treat the globe as the experimental embryologist treats an egg—to preserve it whole in every hour of its development, then section it with a microtome.

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People who are not in the habit of visiting or considering museums fail to realize how prodigiously within recent times the zeal for conservation—or, as Sir Thomas Browne puts it, the diuturnity of relics—has increased all over the world in every center of civilization. A constant stream of objects flows into the great treasuries of human inheritance—about 400,000 separate objects being received into the British Museum in Bloomsbury per annum, and there is scarcely a capital in Europe, or a big town in America, in which congestion is not already being felt.

In a museum you shall find not only the loincloth or feathers of the savage, but an almost perfect series of costumes worn by man down through the ages in any country. Man's past in particular is preserved with the tenderest care. It is possible to go and with the utmost pride and self-satisfaction observe the milestones of our progress from the arrow-head to the modern rifle, from the sedan chair and hobby-horse to the motorcycle and aeroplane, from the spinning wheel to the modern loom, from the Caxton printing press to the linotype, from Stephenson's "Rocket" to the railway express engine, from the windbag of the Roman invaders to the latest ocean greyhound in miniature. It is all there: China, tobacco pipes, door-handles, iron railings, bedsteads, clavichords, buttons, lamps, vases, sherds, bones, Babylonian and Hittite tablets, the Moabite stone, the autographs and MSS. of everyone who was anybody since writing came into common practice, scarabs and coins, scarabs of the Rameses and Amenheteps, coins of Greece and Rome, coins of Arabia, coins of Cyrenaica, coins from Colophon, Tyre, Sidon—Nineveh's Winged Bulls.

I knew a police inspector who saved and docketed the cigar ashes of royal personages, and I once heard of a distinguished chiropodist who saved their nail parings. Mr. Pierpont Morgan owns the largest collection of watches in the world, and another American is the proud possessor of the only complete collection of "Crusoes" in existence: *i.e.*, the editions of *Robinson Crusoe* by Daniel Defoe.

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But not only is the past retrieved in fragments; in some museums and exhibitions, and to a certain extent in historical plays, it is actually reconstructed: In London is displayed the interior of an apothecary's shop in the 17th century, with its crocodile and bunches of herbs, or the shop of a barber-surgeon, or a reconstruction of the laboratory used by Liebig, or the Bromley Room, or Shakespeare's Globe Theater in exact facsimile, or Solomon's Temple, while, for the purposes of illustration, Madame Tussaud's must for the moment be classed with the Pantheon. The cinema is going to keep alive the persons and events of the present generation within the most sluggish imaginations of the next—for those who perhaps won't read history or visit museums. This need not mean the gradual atrophy of the imagination, as some Solomon Eagles portend—to discuss which would, however, mean a digression. In any case, I fancy the most lively imagination would scarcely ignore the opportunity if an authentic film were in existence of seeing Dr. Johnson, let us say, walk down Fleet Street tapping each lamp-post with his stick or of listening to a gramophone record of Rachel or Edmund Burke.

Wherever one turns it is easy to see this thriving instinct of the human heart. There are enthusiastic leagues for preserving woods, forests, footpaths, commons, trees, plants, animals, ancient buildings, historical sites. In times to come, nearly every private house in London will have historical connections and bear a commemorative tablet. In anticipation of its extinction the hansom cab has already been lodged behind the portals of its last depository. Everywhere enthusiasts are expending a vast amount of energy in inducing people to stick to the old—pedants will have you use the old idioms and spellings, the language must be preserved in its original beauty; no ancient rite or custom can be allowed to lapse into desuetude but some cry of reprobation goes up to heaven in righteous anger. There are anniversaries, centenaries, bicentenaries, tercentenaries—glutinous tercentenaries!

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Perhaps the most valuable instrument for perpetuation is the printing press. No sooner is an event over, than it is reported in the daily press and the newspaper preserved in the British Museum for all time. In future there will be no historical lacunæ. In virtue of our elaborate precautions it is improbable that London will ever become a second Nineveh. Immediately a discovery is made or a research brought to its conclusion the world is copiously informed. In the present era of publicity, we need never fear that a man's secret will die with him. It were safe to prophesy that there will never be another Mrs. Stopes, for the good reason that his contemporaries will never let a second Shakespeare slip through their fingers, so to speak. The scholar's lament over the loss of the Diakosmos of Demokritus, or the naturalist's over that of the observations of William Harvey of the Generation of Insects—destroyed in the fortunes of war—will probably never be heard again. Within the sacred rotunda of the British Museum Reading Room may be perused the novels of Charles Garvice as well as the great Chinese Encyclopedia of the Emperor K'ang-hi in 5,020 volumes.

In books our knowledge to date is rounded up and displayed; you may read a book on a lump of coal, a grass blade, a sea worm, on hair combs, carpets, ships, sticks, sealing-wax, cabbages, kings, cosmetics, Kant. A very thick volume indeed was published last year upon the *thorax* of a field cricket. It would require a learned man to catalogue the literature that deals with such comparatively trivial subjects as the History of the Punch and Judy Show, or the History of Playing Cards.

At the present rapid rate of accumulation, the time must come when the British Museum, thousands of years hence, will occupy an area as large as London, and the *Encyclopedia Britannica* be housed in a building as big as the Crystal Palace; an accumulation of learning to make Aristotle and Scaliger turn pale.

For let us not forget that man is only at the beginning of things. The first Egyptian dynasty began 7000 B. C. and we are now only in A. D. 1917. Every day sees the birth of entirely new things that must be collected and preserved, new babies, new battles, new books, new discoveries, so that—to take a moderate figure—by A. D. 3000 we shall have saved up such a prodigious quantity of the relics and minutiæ of the past, that only a relatively small fraction of it will be contained in the united consciousness of the men of that time. Everything will be there and accessible, but for reference only. Knowledge will be an amazing organization (let us hope it will be done better than the Poor Law system), and battalions of men of the intellectual lineage of Diderot and D'Alembert will be continuously occupied in sifting and arranging our stores of information whereby the curious by handing a query over the counter will be given all the knowledge in existence in any particular subject. Yet for the most part human knowledge will be left stranded high and dry in books—entombed, embalmed, labeled and clean forgotten—unless the human brain becomes hypertrophied.

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Conservation is a natural tendency of the mind. One might lay down a certain law of the conservation of consciousness to indicate our extreme repugnance to the idea of anything passing clean away into the void. What insinuating comfort in those words that every hair of our heads is numbered!

True, the chain of causation is unbroken and in a sense every effect is the collection and preservation of

*From *Science Progress*.

all its past courses, and if to live can be said to exist in results, then no man ever dies and no thought can perish, and every act is infinite in its consequences. Yet I fancy this transcendental flourish will not satisfy the brotherhood of salvationists who desire to possess something more than the means embodied abstractly in the result, nor will it cause them to abate one jot their feverish labors to forestall their common enemies—cormorant-devouring Time, man's own leaky memory, Death's abhorred shears, the Futurist, the Hun, the Vandal, the carrion-worm or the Devil.

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The instinct for conservation in different men has different origins. To the scientific man, Nature is higgledy-piggledy until she is collected, classified, stored, and explained according to his own scheme; every phenomenon unobserved or imperfectly comprehended escapes and flows past him, defeating his will to understand. In politics, conservatism means a distrust of the unknown future suited to a comfortable habituation to current customs and current statecraft or—to quote Fluellen—the ceremonies of it and the cares of it and the forms of it and the sobriety of it and the modesty of it. In still another direction, the desire to conserve is simply a sentiment for the old forgotten far-off things and tales of long ago. The flight of time, its likeness to a running stream, the great world spinning down the grooves of change, endless change and decay, have been food for the melancholy ruminations of philosophers from the earliest times. "Tout ce qui fut un jour et n'est plus aujourd'hui incline à la tristesse surtout ce qui fut très beau et très heureux," says Maeterlinck.

But regard for the old is not always vague sentiment alone. In one of his essays, Emerson remarks that Nature often turns to ornament what she once employed for use, illustrating his suggestion with certain sea shells in which the parts which have for a time formed the mouth are at the next whorl of growth left behind as decorative nodes and spines. Subsequently, Herbert Spencer applied the idea to human beings, remarking how the material exuviæ of past social states become the ornaments of the present, for example ruined castles, old rites and ceremonies, old earthenware water-jars. The explanation of this metamorphosis simply is, that so long as a thing is useful its beauty often goes for the most part unobserved. Beauty is the pursuit of leisure, and it was probably in those rhythmic periods of relaxation when the primitive potter or stone carver paused from his labor that the esthetic sense according to some was given birth.

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Now it is certain that there be some to whom the perpetuation of Stonehenge or the Diplodocus is a matter of large indifference, in whom arises no joy in the fruits of the conservator's art upon handling, say, a Syracusan tetradrachm or a folio of Shakespeare with "the excessively rare title-page 'for Richard Meighen.'" Yet over the question of self-perpetuation these same men will be as desirous as others. Few men, save Buddhists, relish the idea of self-extinction. No one likes the thought of the carrion worm in the seat of intellect. The Egyptians bravely fought the course of Nature and gained some solace, we may assume, by embalming. Christians, if they resign themselves to the decay of the body, labor in its stead to save the soul. On his death, every man at least claims a tombstone. The surface of the earth is stippled with crosses (especially in France), with monuments, obelisks, mausoleums, pyramids, cenotaphs, tombs, tumuli, barrows, cairns, designed to keep ever green the memory of the dead, to forestall oblivion lurking like a ghoul in the background. Look at Keats's naive preoccupation with his future fame, his passionate desire to be grouped among the heirs of all eternity. If we are to believe Shakespeare and the Elizabethan sonneteers, their common obsession was to combat brass and stone with their own immortal lines.

No doubt there are a few apparently sincere, high-minded gentlemen ("Rocky Mountain toughs" William James calls them) who emphatically declare that when they die they will, after cremation, have their ashes scattered to the winds of heaven, who scoff at the salvation of their souls, and quote Haeckel's jibe about man as "a gaseous vertebrate," who are indifferent to fame and spurn monuments that live no longer than the bell rings and the widow weeps. In short, since conservation must always be o'erswayed by sad mortality in the long run, they will have nothing of it. "Give me my scallop shell of quiet," they would say—and let the world pass on its primrose way to the everlasting bonfire.

But conservation cannot be so summarily set aside. Every man, willy nilly, collects and preserves, for his consciousness is of itself an automatic collecting instrument and his memory a preservative. After a life of it a man's mind is a museum, a palimpsest, a holdall. In the heyday of manhood we may perhaps go adventuring on in lavish expenditure of life, nomads, careless of the day as soon as it is over. Yet he must be a very rare bird indeed, the veteran who, when all the wheels are run down, does not choose to write his memoirs or even to relate reminiscences around the fireside, the broken soldier who never shoulders his crutch, the barrister who never recalls his first brief. Two old men will haggle with one another over the fixation of a date, they will pull up a conversation and everyone must wait on account of a forgotten name.

In 1768 Fanny Burney made this entry in her Journal: "I cannot express the pleasure I have in writing down my thoughts at the very moment * * * and I am much deceived in my foresight if I shall not have very great delight in reading this living proof of my manner of passing my time * * * there is something to me very unsatisfactory in passing year after year without even a memorandum of what you did, etc." This is the true spirit of the habitual diarist speaking. At heart, everyone is a diarist. There is no child who has not kept a diary at some time or another, and there is no one who, having given it up, has not regretted it later on. The confirmed journal writer, however, possesses a psychology not altogether common, being one of those few persons who truly appraise the beauty, interest, and value of the present without having to wait until memory has lent the past its chromatic fringes.

* * * * * *

It is strange that so many gallant knights clad in the armor of steely determination should fight on unthinking against such overwhelming odds. For the conservators, in trying to dam back time, in resisting change and decay, wrestle with the stars in their courses and dispute the very constitution of the universe. But the imperative instinct must be obeyed. The ominous warnings of Sir Thomas Browne are unavailing. "There is no antidote for the opium of time." "Gravestones tell truth but a year." "We might just as well be content with six feet as with the moles of Adrianus." And "to subsist but in bones, and be but pyramidally extant, is a fallacy in duration." To erect a monument is like trying to insert a stick into the bed of the Niagara. No memorial as large and wonderful as the Taj Mahal can stay the passage of a brief, no pen can preserve an emotion held for a while in the sweet shackles of a sonnet's rules. Neither pen nor brush nor chisel knows the art of perpetuation.

As the torrent races past, frantic hands stretch out to snatch some memento from the flood—a faded letter, an old concert program, a bullet, the railway labels jealously preserved on travelers' portmanteaux, a lock of hair. "Only a woman's hair," said Swift in the bitterness of his heart as he handled Stella's tress.

There are some things we can never hope to recall, even so long as the world lasts, except by divination or Black Magic. The hopeless science of Paleontology offers its students no tiniest ray of comfort—a Pterodactyl, a Dinosaur, or an Archæopteryx will never be disclosed to us in the flesh. There are many things lost forever: Who was the Man in the Iron Mask? or Junius? or Mr. W. H.?—Louvain?

"All is vanity, feeding the wind and folly. Mummy is become merchandise, Mizraim cures wounds, and Pharaoh is sold for balsams"—to borrow once more from Sir Thomas Browne's organ music.

"Tarry awhile, lean earth!
Rabble of Pharaohs and Arsacidæ
Keep their cold court within thee; thou hast sucked down
How many Ninevehs and Hecatompyloi
And perished cities whose great phantasmata
O'erbrow the silent citizens of Dis."

Life is expenditure. We must always be paying away. It is sad to behold the conservators—ecstatic hearts—following like eager camp followers in the trail of the whirlwind, collecting and saving the fragments so as to work them up into some pitiful history, poem, biography, monograph, or memorial.

Why pursue this hopeless task? What is the use in being precious and saving? Nature wastes a thousand seeds, experiments lightly with whole civilization, and has abandoned a thousand planets that cycle in space forgotten and cold. Both collection and recollection are insufficient. The only perfect preservation is recreation. Surely our zeal for conservation betokens a miserly, close-fisted nature in us. It cannot be very magnanimous on our part to be so precious since God and Nature are on the side of waste. Let us squander our life and energy in desire, love, experience. And, since so it is to be, let us without vain regrets watch the universe itself be squandered on the passing years, on earthquakes, and on wars. The world is an adventurer, and we try to keep him at home—in a museum. Let us not be niggardly over our planet nor over ourselves.

Yet it is easy but fatuous to sit at a writing desk and make suggestions for the alteration of human nature. Conservation is as deeply rooted as original sin.

Electric Boiler-Heating for Steam Locomotives

This article suggests that electric boiler-heating offers economic advantages on Swiss steam railways; there are also criticisms by other writers. Kummer considers that electric heating can compete with coal firing for boilers at the present price of coal in Switzerland. Any kind of current may be employed so long as it is transmitted at high enough pressure.

Assuming feed-water at 30°C. the heat expenditure for steam as used on locomotives averages 635 kg. cals. per kg. for saturated steam and 700 kg. cals. per kg. for superheated steam. On the basis of 1 kg. cal. = 1.16 watt-hr., and allowing 86 per cent efficiency for saturated steam or 81 per cent for superheated steam between the line feeding-point and the steam raised, we have an energy consumption of 857 watt-hrs. per kg. with saturated steam, and 1,000 watt-hrs. per kg. with superheated steam. Lines 3 (*a*), (*b*) in the table show the much higher efficiency of direct electric drive, compared with electric heating of steam boilers. Lines 4 (*a*), (*b*) are based on lines (1) and (3), and on coal at 100 fr. per ton and electrical energy at 1.5 Rp. per kw.-hr. Under these conditions, electric heating is 10 per cent cheaper than coal firing. Allowing 0.043 to 0.0.055 Rp. per ton-km. for working line costs, and from 0.015 to 0.01 Rp. per ton-km. for the conversion of steam locomotives to electric heating, the cost of electric heating would be practically equal to that of coal firing. Kummer suggests that tests be made on an electric railway with a steam locomotive fitted for electric heating.

L. Thormann criticises the practicability of the proposed system. This writer allows 1 kw.-hr. per kg. of steam at working pressure; and an energy consumption with electric boiler-heating equal to about 10 times that with electric locomotives. If there is a heating surface of 250 m.² already available on the locomotive to be converted, approximately another 650 m.² would have to be provided, with a construction weight of 52 tons. Probably the extra weight of the electrically heated boiler would be 60 to 80 tons, excluding transformers which would probably be necessary and would add another 80 tons to the dead weight. The crucial point seems to be the heating surface required. Thormann's estimate is much higher than Kummer's owing partly to his assuming that there is no considerable heat storage, so that the heat equivalent of electrical energy supplied would have to correspond to the instantaneous steam demand. Thormann concludes that the weight of an electrically heated boiler and locomotive would be 2 or 3 times that of an ordinary steam locomotive; the former would be costly and increase materially the specific energy consumption, so that energy would have to be obtainable at 1.5 centimes per kw.-hr. to complete with coal firing. This price, at the line wire, cannot be realized.

In his reply, Kummer asserts that 2,750 kw. at the line would provide 417 h.p. at the wheel-rim of an electrically heated locomotive, sufficing to propel a total weight of 350 tons at 25 km. per hr. up a 1:100 gradient. Thormann's assumption of 917 m.² heating surface for 1,036 h.p. (at rim) corresponds to 1.13 hp. per m.², whereas 4 to 6 h.p. per m.² is commonly obtained with locomotive boilers providing saturated steam, and 6 to 8 h.p. per m.² with superheated steam. Kummer does not agree that the locomotive weight would be much increased by electric heating; as compared with plain electric drive, the electrically heated boiler would be able to accumulate energy during station stops and whilst running downhill.

A. Trautweiler suggests that surplus electrical energy if available free, could be used advantageously to preheat feed-water for locomotives up to 90° C. or so in stationary plant at depots. At a medium-sized depot 250 m. of feed-water might be required daily for 20 locomotives. If 5,000 kw. spare capacity be available for 5 hrs. each night at an adjacent power station, this could be utilized (at 80 per cent efficiency) to warm the 250 m. of feed-water through 70° C. This would correspond to a saving of 3,000 kg. coal per diem. Even on the basis of peace prices for coal, this saving would cover the costs and charges on the pre-heating equipment. Note in *Science Abstracts* on an article by W. Kummer, in *Schweiz. Bauzeitung*.

The Total Eclipse of the Sun of June 8, 1918*

Where it Can Be Seen and What Amateur Observers Can See

By H. C. Wilson

On the afternoon of the 8th of next month, between 7 h. 29 m. and 12 h. 46 m. Greenwich mean time, will occur the most notable astronomical event which has been predicted for this year. On that day the moon will pass so directly between the earth and the sun that its shadow-cone will fall upon the earth and will sweep across the United States diagonally, southeastward from Washington to Florida. Diagrams of the shadow path have already been published in this magazine (See the January, October and November, 1917, and January, 1918, issues of *Popular Astronomy*).[1]

The shadow will have passed over more than half of its course across the earth when it reaches the United States, for it touches the earth first in the Pacific Ocean south of Japan, then passes northwestward, reaching its highest latitude about 500 miles south of the Alaskan coast, in longitude 152° west from Greenwich. From there its course is southeastward, striking land first on the western coast of Washington. The little city of South Bend, one of the western terminals of the Northern Pacific Railroad, several miles south of Aberdeen, is very close to the center line of the shadow path. This city will have the longest duration of totality of all the stations in the United States. The moon's shadow will there be about 66 miles in diameter and will take 2 m. 1 s. to pass a given point. The sun's disk will therefore be entirely covered by the moon for two minutes. Unfortunately the chances of clear weather at South Bend are very small and observers who go from a distance to see the eclipse will seek more inland stations where the chances for clear weather are more favorable.

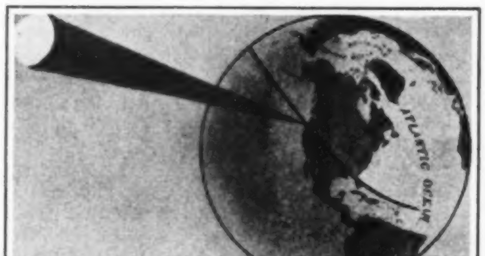
As the shadow passes inland its diameter becomes gradually smaller and its motion relative to the surface of the earth swifter, so that the time during which the sun is wholly covered by the moon gradually diminishes. At Baker City, Oregon, the first city of any considerable size near the center line, the duration of total eclipse will be 1 m. 53 s. At Denver, Colorado, totality will last only 1 m. 30 s.; at Ashland, Kansas, 1 m. 19 s.; near Guthrie, Oklahoma, 1 m. 15 s.; near Yazoo, Mississippi, 1 m. 5 s.; at Orlando, Florida, 50 s.

The total time occupied by the passage of the shadow from coast to coast, Washington to Florida, will be only 47 minutes. It will arrive at the mouth of the Columbia River at almost exactly 2 h. 55 m., Pacific Standard time (3 h. 55 m. Pacific Summer time); at Baker, Oregon, at 3 h. 05 m. Pacific Standard time (4 h. 05 m. Summer time); at Denver, Colorado, at 4 h. 23 m. Mountain Standard time (5 h. 23 m. Summer time); at Yazoo, Mississippi, at 5 h. 39 m. Central Standard time (6 h. 39 m. Summer time); and at Orlando, Florida, at 5 h. 41 m. .5 Central Standard time.

There are about 80 towns within 20 miles of the central line of the path of totality, as shown by the map issued as a supplement to the American Ephemeris for 1918, and almost all of these are accessible by rail. Perhaps as many more towns are within the path, but closer to its edges so that the duration of totality will be shorter. At all of these, observations of value can be made of the eclipse, and people living in these vicinities will have the privilege of witnessing a most magnificent spectacle, without the expense and inconvenience of travel and transportation of apparatus. Thousands of people living short distances on either side of the shadow path will doubtless travel those short distances in order to witness the spectacle from as favorable locations as possible.

Those who have to stay at home will not lose all of the show, for the eclipse will be visible as a partial eclipse all over North America. Even at Los Angeles, California, and at Washington, D. C., the moon will cover three-fourths of the diameter of the sun's disk. At Augusta, Maine, fifty-eight hundredths of the diameter will be covered. At all points, then, in this country observers will have the pleasure of watching for the first indentation of the solar disk by the black body of the moon, of following the progress of darkening to its maximum at the middle of the eclipse, then its decrease until the last vestige disappears at the end of the eclipse. The times of the first and last moments, known as the first and last contacts, should be noted and recorded as exactly as possible, together with comparisons of the watches used with telegraphic time signals from Washington both before and after the eclipse. The predicted times of the contacts for the principal cities of the United States were given in the January, 1918, number of *Popular Astronomy*, p. 49.

What are the things to be looked for by those who are fortunate enough to be located within the shadow path? First of all will be the beginning of the partial eclipse, first contact, just the same for observers within as for those outside the shadow path. Then there will be the progress of the black moon across the face of the sun, its passage over the sunspots, one after another, the times of which may be noted, and finally the moment the last tiny speck of sunlight vanishes. Some time before this the darkness in midday will have become weird. Those who are not occupied with special astronomical observations should watch the actions of birds and animals. See if the chickens really



Moon's shadow and path across earth
By Dr. B. M. Baumgardt of Los Angeles

go to roost! Notice the shape of the spots of sunlight under the trees. See if any of the stars or planets are visible, and just when they become visible. A few moments before the sun is wholly covered watch for the coming of the shadow of the moon from the northwest. Its swift approach, when seen from a high point, is said to be terrifying. The writer was too busy at the time of the eclipses which he has witnessed to watch for this. Two or three minutes before the shadow comes watch for the shadow bands or ripples of light and shade, which may be seen on light colored ground or sheets of white cloth spread out for the purpose. Mark the direction and distance apart of the bands by laying down a pair of long sticks parallel to them and at the proper distance apart. This should be done as soon as the bands are noticed, and again at the beginning of totality.

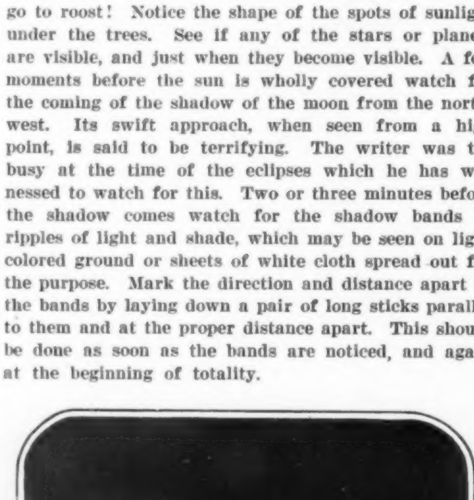


Figure of the total solar eclipse of May 28, 1900
From a photograph by H. C. Wilson, at Southern Pines, N. C.
Exposure 30 seconds

Then comes the supreme moment of the eclipse. The instant the sun is wholly covered (it may be seen dimly a few seconds before) there stands out, all around the jet black disk of the moon, the wonderful *corona*, a pearly light with streamers extending out here and there to two and three times the moon's diameter. This can be seen at no other time than during the few moments of totality and no evidence of it can be obtained at any other time with any apparatus which has yet been devised. This is why the astronomers spend so much effort and time and go to most distant parts of the world in order to observe total eclipses of the sun. All the eclipses of a century furnish only a comparatively short time in which to observe this mysterious and marvelously beautiful phenomenon.

The corona varies in structure from eclipse to eclipse, but seems to repeat nearly the same form in the years of the sunspot minima. The photograph reproduced here was taken at the eclipse of May 28, 1900, and illustrates the type of corona at the minima of sunspots. The brighter streamers are in general parallel to the sun's equator. This year is not far from the time of sunspot maximum, so that we may expect to see a different type of corona, with some streamers making large angles with the sun's equator.

Observers with small telescopes will do well to spend most of the time of totality in looking at the intricate details in the structure of the inner corona, fixing in mind forms and colors of small portions for future description and sketching.

Observers with only opera glasses or the unaided eye may search for faint extensions of the coronal streamers which will escape delineation by the camera. It is doubtful whether it is worth while to attempt to make sketches of the brighter parts of the corona, as these will be better caught by the camera.

All too soon totality will be over. Third contact, the moment when the first ray of bright sunlight appears between the mountains on the edge of the moon, must be noted, then the phenomena of the shadow bands and the swift recession of the shadow of the moon may be observed in reverse order to that preceding totality, and after that the slow increase of the solar crescent, the reappearance of the sunspots and at last the exact moment of disappearance of the black notch to be noted.

So far I have written of what the amateur may do, who is free to do as he pleases and not bound to do some specific thing which is designed directly to add to our scientific knowledge. What of the professional astronomers?

They will be scattered along the path of totality from Goldendale, Washington, to Hartland, Kansas, and possibly Orlando, Florida, seeking chiefly those locations which promise the best weather conditions (See the articles by Professor Frost in the February number and by Professors Todd and Townley in the March number of *Popular Astronomy*). They will be watching some of the things which I have already mentioned, but primarily their attention will be directed to the solar corona. They will endeavor to obtain photographs on large and small scales, to show the details of both the inner and the outer corona, and any changes which may occur while the shadow is crossing from Washington to Florida. They will study its light with the spectroscope, and with various forms of photometer, bolometer, and polariscope. They will photograph, if possible, the "flash spectrum" at the moments when the dark lines of the solar spectrum become bright lines, and the position of the "coronium" line will again be determined, if it is sharp enough and bright enough.

Photographs of the region around the sun will be taken this year, not as usual for the purpose of discovering "Vulcan" or other hypothetical intra-Mercurial planets, but for a possible test of the Einstein theory of relativity. If good plates are secured they will be measured to see whether or not the apparent places of stars are shifted by the passage of their rays through the gravitational field of the sun. This is perhaps the most important problem of all those to be considered in connection with the eclipse, but it is a question whether there are stars close to the sun bright enough to show through the coronal light, and whether the corona itself may not produce some shift in the rays of light from the stars.

The accompanying chart shows the stars that will be within 30 degrees of the sun at the time of totality. At Denver the sun will be at an altitude of 32° above the west horizon. Jupiter will be seen above and to the left of the Sun, Aldebaran directly below and Mercury twice as far below and to the right. To the left will be Orion, with the two brilliant stars Betelgeux and Rigel almost certainly visible and the belt possibly seen. Above, to the left, will be Castor and Pollux and to the right will be Capella in Auriga and possibly other stars of that constellation and in Perseus. Close to the sun are no stars brighter than fifth magnitude.

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* *Popular Astronomy.*

[1] See also Scientific American Supplement No. 2145, Feb. 19, 1917, p. 93.

Covering Power of Lenses and Stray Light in the Camera

MANY photographers when they purchase a lens have not the opportunity of testing its performance upon a plate very much larger than that which it is listed to cover, and so do not come to a clear realization of what its properties are in respect to the qualities which commonly go by the name of "covering power" and "illuminating power." Generally speaking, it is assumed that covering power of a lens is a property which is to be desired to the fullest extent. The object of these notes is to set forth the doctrine that, within certain limits, the contrary is true, and that while we owe a great deal to the opticians for the progress they have made in providing lenses of great covering power we have at the same time largely blinded ourselves to the definite advantages of lenses of the older type which exhibit this quality to a much lesser degree.

It may first be desirable to obtain a practical definition of what is meant by covering power as distinguished from illuminating power. The former term relates to the size of plate, or rather to the diameter of field, which a lens of given focal length will cover with sharp definition to the margins when pointed upon a flat subject. The subject requires to be flat, for if it is one consisting of objects at various distances, a lens which possesses what is known as curvature of field may chance to exhibit better performance in the way of covering power than another which actually is superior. On the other hand, illuminating power denotes the size of plate or diameter of field which, in the same circumstances, is filled with definition *of a kind*. The definition may not be good, but nevertheless the lens will form some kind of image on the plate right up to the edges of the disc which mark the limit of illuminating power.

Now, in the views which are commonly expressed in text-books on photographic optics it would seem that the more covering power a lens possesses the better it necessarily is. Thus, to quote a passage in one manual on the subject, "the larger the circle covered by a lens of given focal length the better, because the lens can be moved about on the camera front without fear of ill-defined corners in the negative, and also because the lens can be used to cover a larger plate." Undoubtedly this expresses a large measure of truth, inasmuch as the conditions named in it correspond with those which prevail very frequently in practical photography. But in an extensive reading of text-books and catalogues dealing with photographic lenses I have rarely found any attention given to the effects which different lenses produce in these matters of covering power and illuminating power. While it is true that ample covering power has its advantages when you use the camera with the lens raised or lowered, or when you seek to cover a larger plate, it is perhaps not so clearly kept in mind that when you are not using a lens under these conditions the reserve or covering power is not then negatived or annulled, but has its effect in the way of illuminating the bellows of the camera, thereby creating a source of stray light within the camera which is a cause of many complaints of veil or flatness in negatives. This effect, of course, takes place equally whether it comes from great covering power of the lens or from its wide "circle of illumination." So far as concerns the creation of stray light within the camera, it doesn't matter whether the illumination of the bellows is due to the margins of an unsharp or a sharp image. The effect is just the same in producing a secondary source of light within the camera which, in the absence of means to cut it out, must have its effect upon the plate.

The outcome of these considerations is that for many of the purposes which come in the category of ordinary photography a lens of covering power such that its field extends very little beyond the dimensions of the plate will prove in practice to yield results which are thoroughly comparable with those by an anastigmat costing a good deal more. This applies to such work as copying, photography of ordinary views, and in general to subjects where (1) there is no call to bring the lens out of center with the plate, and (2) where it is not necessary to work at a very rapid aperture. The anastigmat, with its large working aperture and its ability at that aperture to cover a relatively large plate, has tended to render us less appreciative of the results which can be obtained with the now despised R. R. type of lens in circumstances where one or other of these two conditions does not require to be fulfilled. It is true that the definition towards the margins of a plate yielded by an R. R. lens at its full aperture compares unfavorably with that of an anastigmat at *its* full aperture. But when both lenses are stopped down to a medium aperture, such as *f*/16 or *f*/22, the difference in the performance of the two largely disappears, and in these circumstances the R. R., from its lesser degree of covering power and smaller circle of illumination, scores on the ground of yielding negatives of a degree of brilliance and sparkle which often it is difficult to secure with an anastigmat of similar focal length. I have no doubt I am telling a tale which is familiar enough to those who have lived through the era in photographic lenses which includes the coming of those of the anastigmat type. Old hands who have had the occasion and opportunity to compare the actual performance of the newer lenses with those which previously were their accustomed instruments, and under the conditions formerly applying to those instruments, have discovered for themselves that the merit of the anastigmat—let there be no thought of disparaging it—lies in the direction of creating better performance under fresh conditions which ating better performance under fresh conditions which quality of work such as one was accustomed to turn out in the days when the R. R. was the universal lens and its limitations were recognized.

The moral of all this—and it is one which may not inappropriately be drawn to the notice of photographers in these days, when it is difficult to purchase anastigmat lenses—is that the precise purpose for which a lens is to be used should be carefully considered. It is not advisable to jump to the conclusion that an anastigmat, if it can be got, is necessarily going to do any better work than an R. R. of the same focal length. Probably it would surprise many of those who imagine that the anastigmat is the lens par excellence for copying to observe in process studios the frequency with which an R. R. figures on the copying camera. Moreover, the choice of an anastigmat of large aperture is apt to be particularly elusive when one of considerable focal length, such as 10 inches and more, comes to be purchased. Here another factor quite apart from that of covering power comes into play, namely, depth of focus. Assuming broadly that the depth of focus which is commonly called for in negatives is conditioned by the actual diameter of the lens stop (not by the *f*/ number), it will be seen that in using a long-focus lens it is generally necessary to use a medium or even a small stop to secure sufficient depth of focus. Obviously, then, there can be no useful purpose served in buying an expensive lens which works at *f*/4.5, when, for 90 per cent. of the subjects which are photographed with it, it requires to be stopped down to *f*/16 or *f*/22 simply for the purpose of obtaining sharp definition. This, again, is a point which I am sure is familiar to photographers who have had much experience in the use of long-focus lenses in general outdoor photography. It is another of those instances which leads one to the general conclusion that in photographic optical equipment, as in that for other crafts such as woodwork or metal-working, it is a bad practice to endeavor to make one tool serve several purposes. Most certainly that applies to lenses. While the anastigmat with its large aperture and its great covering power has its specific usefulness, the older type of lesser speed and lower covering power equally is unexcelled, as regards all-round quality of work, for certain purposes.—GRAHAM M. NICOL in the *British Journal of Photography*.

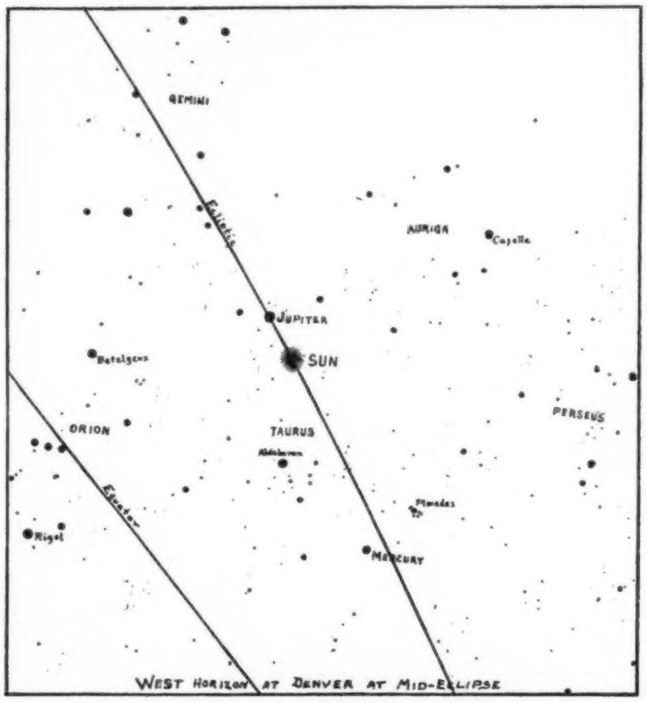

Chart of the stars in the vicinity of the sun at the time of the eclipse, June 8, 1918

The Corrodibility of Cast Iron

ATTENTION was drawn to the fact that the ultimate analysis of cast iron as usually stated gives a very imperfect indication of the purity of the metal. If the normal impurities in cast iron were reckoned as compounds they would constitute some 25 per cent of the material instead of the 7.5 per cent indicated by the usual method of recording the analytical results.

When the metal cools from fusion its ultimate character depends on the behaviour of the compounds present, and not on the elements. The carbide under certain conditions may decompose to form graphite, but the other compounds do not decompose. The portion last remaining fluid retains practically the whole of the phosphorus, and has a very low melting point.

In the solidification of castings the liquid portion subsides by gravity into the lower parts of the casting so long as a clear way exists, and produces cavities. In the attack of chemical vessels it was shown that actual corrosion had occurred on each side of the graphite akes. Cavities in the association with the phosphide eutectic yielded on exposure an efflorescence of iron salts in patches all over the fractured surface.

Reference was made to the very rapid failure of pans, after having been long in use, when subjected to more drastic treatment. It was shown that this was due to the surface having been removed by solution, thus exposing the more open and more highly phosphoric metal in the center of the casting specimen, and analyses showing these differences were given. The ultimate cracking is due to the bursting pressure produced by the increase in volume due to corrosion.

In the case of high silicon alloys used for chemical vessels the same conclusions hold good; graphite should be absent and phosphorus at a minimum. Specimens showing the effect of the presence of both of these were exhibited and the analytical data presented proved that, when acted on by acids, the phosphide was attacked preferentially. Pellets were found in phosphoric silicon metal used for chemical purposes and the concentrations in the vicinity of blow holes demonstrated. Analyses of the pellets showed them to contain more than ten times the proportion of phosphorus present in the metal.—Notes on paper by E. L. RHEAD before the Manchester Section of the Society of Chemical Industry.

Alcohol in Internal Combustion Motors

THE chief difficulty likely to be experineced in bringing alcohol engines into general use is that some special means must be provided for starting the engines from cold. This difficulty is not likely to be so serious an objection in the case of stationary engines as in motor-car engines.

Alcohol is more efficient in engines of low-piston speed and long stroke. This is due to the fact that when alcohol is used in a high-speed motor, since the fuel ignites slowly compared with petrol, the propagation of the flame is not sufficiently rapid to suit a high-piston velocity and a piston travel which is too limited in range. The alcohol engines used in Germany are almost entirely of the high-compression slow running type, and, although the design of engines of this type seems to have been worked out fully in that country, comparatively little work has yet been done on the high-speed type of engine used for motor cars. Until the outbreak of war the German motor manufacturer had a larger market outside his own country than in it, and it has not been to his advantages to develop a type of engine which can be used with a fuel generally available in his own country only.

The problem of distribution of alcohol is not likely to be so serious in the case of stationary engines as for the general adoption of the spirit for motor cars. It appears likely that the local manufacture of power alcohol and its utilization in the vicinity of manufacture may be a potent factor in the development of alcohol fuel and engines.

Volcanic Eruptions

A Possible Explanation of the Mechanical and Thermo-Dynamic Results

By Geo. N. Cole, Ass'n Am. Soc. M. E.

There are certain phases of physical destruction and damage following a volcanic eruption for which narrators of those events have invariably failed to assign a definite cause. Word pictures from the brush of scientists and popular writers give perfect and consonant details of the effects of those lurid cataclysms, and hold us spellbound at the writhing of nature in awful torment. When, however, the picture being varnished, they set about searching a cause for all the devastation they have so minutely depicted, words falter, and certainty vanishes.

From the younger Pliny to this date, from Pompeii to Martinique and Katmai, come the same stories of titanic manifestation with almost identical descriptions of effects. Each historian essays to assign a cause and in varying wording comes from each the uncertain answer, "The hot blast." But the how or why and the detail of the "hot blast" has been left untouched in its all-embracing mystery from century to century. Perhaps hot blast is fearful enough as a fact without speculation as to its further analysis. Our attention was first attracted by the seeming problem in the statement of a witness of the finding at Martinique of bodies blistered and killed by the "hot blast" on which a covering of the frailest lace was unscorched and whole, and it occurred to us that only the heat of what is technically known as the heat of adiabatic compression could give rise to this puzzling condition and such other nicely-graded phenomena as we found, upon search, recorded in the bibliography of recent eruptions. Therefore, it is the purpose of this paper, as simply as may be, to marshal the descriptions and explanations of eminent and able writers and show their unanimity on descriptive points and deduce therefrom that there is a definite and outstanding logical answer to the question they all ask. That that answer is based on certain physical phenomena which are in common use in our laboratories and industries and which in wider application covers without flexure the premises of the atmospheric heat phenomena of volcanic action. We will turn one new leaf further into earth's problems.

When an eruption of a volcano takes place, the whole phenomenon depends upon pressure. Pressure in an enormously magnified way but similar to such as takes place in a great gun. Pressure caused by the pent-up material of the volcano which breaks forth as gas, vapor, ash, and lava when the final burst arrives. Iddings in his comprehensive book "The Problems of Volcanism," page 4, states that "In August, 1883, in the volcano of Krakatau a block of rock was thrown 30 miles and is estimated to have risen 31 miles in flight." This was a rough, misshapen stone and the pressure starting it was applied along no retaining rifled gun bore but simply as a fan-shaped, or rather bouquet-shaped, flare behind it that hurled not only this rock but a whole mountain before it. Ordnance experts placed the bursting pressure of Lyddite at 139,000 pounds per square inch and of T. M. T. as 123,000 pounds.

The earth pressure that starts such an appalling catastrophe is incomprehensible. It is beyond all attempt of measure. We admit its presence, we conjecture its amount. To counteract and absorb its energies we only know that when gases and mountain attain their motion there is nothing but the viscosity of the air to oppose it. Every bit of pressure that mountain and gas set up the surrounding air must take up and distribute to dissipation, for action and reaction must be equal. The gases liberated and the heat supplied from super-heated matter, and gases in conflagration, add the impulse of self-expansion due to this heat, as does the burning gasoline in the automobile cylinder, so that every particle of air for miles about is crushed to its minimum volume, proportional to the pressure applied, in order to equalize that applied by the volcano. The volcano gases may go some distance, mainly upward on account of their temperature, but the pressure due to their initial activities will be carried through all the air for leagues around in the pressure that in devastating force wrecks buildings and uproots trees. Picture the pressure that will spread in all directions for a score or more of miles in an interval of three or four minutes as the evidence shows that that of Mt. Pelee did.

This pressure is opposed by the surrounding air, and while it is rapidly equalized, there is a short interval during which each cubic foot of air in the field of action is under this shifting, but terrific pressure, and due to this pressure, is put in motion and compressed, proportional to the amount of pressure applied. Air cannot transmit pressure without being itself compressed in proportion to that pressure. The buffer springs on a backing train are compressed even if the train be moving.

Whenever air is compressed, its temperature is raised in proportion to the pressure applied.

To obtain an authoritative basis for this heating reaction of air to pressure, let us quote from Prof. Spinneys Physics (Macmillan, 1911), page 230, the classic experiment of the "fire syringe."

"A simple experiment for illustrating the transformation of mechanical energy into heat is the following: In the Fire Syringe we have a hollow cylinder having a tight fitting piston. If the piston is forced into the cylinder, the air contained in the cylinder will be compressed and heated, the work done in moving the piston being transformed into heat. If the cylinder is filled with air at ordinary room temperature and pressure and the piston is very quickly forced into the cylinder, the temperature attained by the compressed air may be high enough to ignite a bit of inflammable tinder, attached to the piston, which will continue to burn after the piston is withdrawn."

In paragraph 471 of Ganots old physics we learn that the inflammation of cotton saturated with ether or carbon disulphide in their similar experiment, "indicates a temperature of at least 300° Fahrenheit."

Air always generates heat when it is compressed. In some cases by special cooling arrangements or by the slowness with which the compression is brought about, the temperature of the air is never allowed to rise, and the process is technically known as *isothermal* compression. When, however, the heat remains within the air as the compression takes place, due to the rapidity of compression or to special heat insulation, the term applied in thermo-dynamics to the process is *adiabatic* compression. There are similarly isothermal and adiabatic expansion with the same rules governing except that there is a lowering of the temperature when air is expanded. In order to obtain some comprehension of the temperatures generated under ordinarily observed and recorded conditions within the range of every day use and experiment within commercially attained limits let us cover a portion of the published field of information.

From Richards compressed air tables, we find that in raising the pressure of air from normal to one hundred pounds per square inch, that the temperature will be raised to 556° Fahrenheit, if the action is started at 100° Fahrenheit, and is further raised to 781° Fahrenheit, if the pressure is raised to two hundred pounds. The air that is compressed to operate a naval torpedo is used at approximately 3,000 lbs. per square inch. We admit air into the cylinder of a compressor at a temperature of 60° Fahrenheit, and at normal atmospheric pressure this temperature will reach 415° Fahrenheit under compression, when the gauge registers 75 lbs., thus showing an increase of temperature of 355° Fahrenheit.

To illustrate this still further, where a volume of air is adiabatically compressed, i. e., without cooling, to 21 atmospheres (294 lbs. gauge pressure) it will occupy a volume a little more than one-tenth its original size and the total increase in temperature—if we start at an initial temperature of 60°—is about 800°, and if we start at 100° initial temperature the increase is 900°.

For further and commercial illustration let us consider that the emergency action of the well-known Diesel engine is obtained by spraying oil into its cylinder into air superheated by the application of this principle of compression after the piston has forced it into a small per cent. of its former volume. This compression has raised the pressure of the air to about 600 lbs. per square inch, at which its temperature is 1,100° Fahrenheit, thus igniting and exploding the oil, and so actuating this make of engine.

Other examples of heat due to compression will occur to the reader. It is not only a proven condition, but it has long been mechanically and economically applied. These temperatures are proportional to the pressures and in volcanic eruption are as much higher and beyond computation as are the pressures.

The intense pressure and its coordinated heat generated by a volcano is rapidly dissipated in the air over the rapidly advancing surface of action approximately semi-spherical, but much distorted. Its effect will travel for miles, especially along the concentrating shape of valleys which hem it in, conserving its destructive properties. It possesses the combined weapons, first, of fiercely rapid movement, only retarded by the viscosity of the air, and, second, by the automatically generated, self-contained heat inherent in each particle, due to the compression under which it is placed.

If air were non-compressible or did not heat under pressure, it would bank its cold mass in front of the advancing blast and insulate and protect every object in its track. This does *not* occur. The pressure penetrates the air and by its compression produces heat everywhere until dissipated by expansion or the absorption of its heat.

Physically heat as ordinarily encountered is transmitted in straight lines by radiation direct from source to object as in a room heated by a grate fire or further is transmitted by convection currents of variable course as when one room is heated from the excess heat coming in the air from another.

In the volcanic phenomena, with the heat penetrating to deep caverns, the straight line of heat radiation and the variable course of convection currents do not govern. It is the heat generated in each particle of air due to its compression that rends, bursts, ignites, scorches or blisters wherever it rests no matter how devious the track. It bears no flame, it bears no odor, it carries only the dust of its advancement and that dust absorbs heat, does not generate it.

It is the air, probably from near the victim, and not the gas generated at the crater, that, caught in the clutches of the general catastrophy, is compressed and with the inborn heat of that compression stifles and blisters the subject, without singeing the cloth covering his deeply burned body. It is the nicety of the gradation of the temperature of this kind of heat that most certainly identifies it as the source of the much questioned and discussed destruction which seems to have baffled observers unaccustomed to the problems of applied thermo-dynamics.

Amazed by the super-hurricane effects of the compression they have barely guessed the counter-vacuum effects and altogether missed the fact that the heat was not brought from the volcanic fires but *made on the spot* by the transmission through the air of the volcanic pressure.

If one could consider a suitably reinforced chamber or room containing ordinary and variously combustible objects with a variety of living things, connected to and acting as the pressure tank of a huge cylinder and piston that might instantaneously or most slowly compress the air in this room; then, by a super-elastic stretch of the imagination we can picture all manner of compression heat effects almost entirely divorced from the tempest effects of nature's manifestation.

Imagining ourselves to be experimenting in such a room or chamber, it would depend entirely upon the rapidity of the compression as to the results of the experiments. If the compression were so slow as to allow the heat to be conducted away as it is formed, or isothermally, we know from every-day caisson experience that man and animals would readily survive up to one hundred pounds pressure to the square inch, for this is ordinary practice in diving and foundation building operations, provided of course that the pressure is so slowly removed as to prevent caisson disease. While it is problematical what would happen to men from other causes than heat, it is axiomatic to state that the pressure could be raised *isothermally* far beyond all present experimental possibilities without the heating of the most diaphonous material. If, however, the air in the chamber be compressed close to instantaneously, no arrangement being made for the dissipation of the heat, or compressed *adiabatically* as it is technically termed, the temperature would rise proportional to the pressure generated. The men and animals who readily survive one hundred pounds of pressure *isothermally* applied would find themselves, under the quicker, the *adiabatic*, conditions bathed in an atmosphere of temperation, by tables in general use, of 425° Fahrenheit. A temperature that will melt solder give a third-grade burn to the flesh and yet not singe the hair, wool or

cotton. If adiabatically the pressure is raised to two hundred pounds, the temperature will rise to about 600° and cotton flames, wood chars, lead melts and flesh burns. At three hundred pounds the temperature is 800°, wood burns. The amount of compression and temperature is indefinitely greater in volcanic action and the variety of resultant conditions gives a most interesting method for finding regions which have undergone equal stress.

Volcanic compression of the air is very close to true adiabatic compression for the first few minutes of onslaught and therein lies the secret of the source of the mystifying heat effects that blister and kill but do not inflame in the outer zones of volcanic destruction.

Having established that there is ungovernable and unmeasurable pressure due to the volcano itself, that this pressure generates heat in regions and spots which the flame and smoke and gas of the volcano cannot penetrate, let us turn to the evidence submitted by various authors and scientists and ask ourselves whether we are ready to answer the question where they hesitated, if we have come upon another of nature's secrets, if we can tell why flesh blisters under unscorched clothing and laces.

It is well known that in Pompeii and Herculaneum men are found in the unchanged attitudes of their daily occupations and Pliny in his letters, Book VI, 16, relating the death of the elder Pliny, relates: When day came (I mean the third after the last he ever saw) they found his body perfect and uninjured, and covered just as he had been overtaken. He seemed by his attitude to be rather asleep than dead.

In *Century Magazine* for September, 1902, Prof. Israel C. Putnam, professor of Geology, University of Michigan, in discussing (p. 797) "Phases of the West Indian Eruption," takes up the question of "What was the immediate cause of death in St. Pierre?" at some length, as follows:

"The loss of life in St. Pierre is placed at about 30,000 "souls. So far as known, not a person survived who "was in the city at 7.55 on the morning of May 8th. "(Note, however, Kennon's case of Ciparis.) Of the "people on the ships in the roadstead of which there "were about eighteen, a few escaped, and most of these "were seriously burned. The death dealing blast did its "work not only thoroughly but quickly. The people "in the city are believed to have been killed in the "space of three minutes, and judging by the reports of "survivors who were barely touched by the scorching "dust, death was in most instances instantaneous, or "nearly so. The immediate and general cause of the "loss of life has by some been ascribed to burning gas "and by others to the inhalation of steam charged with "hot dust. Of these two explanations, the facts ob-"served by me, and the best interpretation I have been "able to place on the reports of survivors who wit-"nessed the disaster in part, decidedly favor the conclu-"sion that steam, and particularly the hot dust with "which it was charged, was the chief cause of death. "In advancing a general explanation of the loss of "life, exceptions need to be noted.

"Many people were no doubt killed by falling walls "and some died from what is termed 'shock' and others "by electricity, *but the great majority of the fatalities "were certainly due to something else, a something "which was widespread and rapid in its action.* (The "italics are ours.)

"As to the cause of death, where the death-dealing "agency was most intense, we can judge, but, as it "seems to me, by considering what occurred on the "outer margin of the devastated area, and especially "from the nature of the injuries of the people who "narrowly escaped with their lives. Of the persons "who survived the destruction of the ships in the road-"stead at St. Pierre, those injured suffered mainly "from scalds and burns inflicted by steam and hot dust "which adhered to the skin and destroyed the epidermis. "In many instances the hair on the injured parts was "not consumed. In the case of sufferers, also, the por-"tions of the body protected by clothing, even to the "extent of a light cotton shirt, were not burned. While "the injured were scalded by steam and burned by hot "dust, the heat was not sufficient to burn hair or "clothing, but it inflicted severe injuries.

"This evidence shows clearly that the people were "not exposed to the touch of burning gases, for if they "had been, their clothing and hair would certainly have "borne evidence to that effect. As told by the heroic "Ellery S. Scott, chief officer of the *Roraima*, the mate-"rial which fell on the ship was in part in the condi-"tion of hot mud.

"The explanation of this occurrence seems to be that "the steam was condensed to water, which being min-"gled with the previously dry dust, formed what was in "reality adhesive hot mud. This, it is fair to judge, "occurred near the outer limit of the region of de-"struction, nearer the center of the devastated area; "and whenever the heat was not sufficiently decreased "to permit the steam to condense, it was charged with "dry hot dust.

"Judging from the evidence in hand, the immediate "cause of death in the case of a very large majority of "the people in St. Pierre was from inhaling steam "charged with hot dust. The dust was fine and in the "process of inhalation would enter the throat and lungs "as readily as gas. (Note, however, that it would need "to be more than the 'tidal air' of respiration to reach "the tubules of the lungs so rapidly.

"In addition to what has just been stated, we have "testimony showing that in many instances the mucous "membrane of the nostrils and mouth in the case of the "people who died was severely blistered and protrud-"ed, so as to be conspicuous. The conclusion here pre-"sented in relation to the cause of death in St. Pierre "find support also in the evidence concerning the dead "and injured on St. Vincent."

Robert T. Hill, geologist, U. S. Geology Survey, in the same magazine (p. 785) in his article, "A Study of Peleé," in discussing the theories of the destruction of the town and people sets down, "There are two theories:

"1. The heat-blast theory. This assumes that the la-"pilli, gases and steam of the cloud were ejected with "sufficient initial force to destroy buildings two to five "miles distant, and were sufficiently hot to inflame the "city and destroy the people by singeing, suffocation and "asphyxiation.

"2. The aerial gas explosion theory. This postulates "that the weight of the cloud, causing it to descend, "the exhaustion of air, the flame and the great aerial "force developed were the products of an explosion "caused by the union of the gases of the cloud with "the oxygen of the air which took place in the air, but "near this surface of the ground." After which the author advances a hypothesis of his own that the action might have been due to electrically charged clouds encountering heated ones. He plays close to the real reason in noting the following effects: "Not only was "there a tremendous outward force, but this was fol-"lowed by a return movement, as if a vacuum had been "created."

In his volume on Problems of Volcanism (p. 4) Joseph P. Iddings would seem to hold the broad "hot blast" theory with a leaning toward convection currents direct from the eruption, as is set down in the following general discussion of the atmospheric activities.

"While mild phases of volcanic activity become cus-"tomary phenomena to the people of some regions, and "attract comparatively little attention, violent eruptions "are always terrifying and occasionally are appalling "in their destruction of human life, and property as "when in May, 1902, the eruption of Mt. Peleé destroyed "the city of St. Pierre and its 28,000 inhabitants by a "downward rushing blast of scorching acid vapor, with "subsequent eruptions of similar scorching clouds be-"sides vertical outbursts of vapors, and showers of dust "with floods of water in other parts of the mountain."

Delving still deeper into the subject, by quoting probably the only living witness who has experienced a full measure of volcanic compression, let us turn to where Mr. George Kennan, in his extensively quoted book, "Tragedy of Peleé," on page 74, recites the personal and corroborated statement of Auguste Ciparis, a negro, fairly intelligent, confined in a dungeon of the town jail at St. Pierre at the time of the eruption; Mr. Kennan continues as follows:

"He had been more frightfully burned, I think, than "any man I had ever seen. His face strangely enough "had escaped injury and his hair had not even been "scorched, but there were terrible burns on his back "and legs, and his badly swollen feet and hands were "covered with yellow and offensive matter which had "no resemblance whatever to human skin and flesh.

"The burns were very deep, so deep that blood oozed "from them, and to my unprofessional eye they looked "as though they might have been made by hot steam.

"When asked to describe all that happened at the time "when he received these burns, Ciparis said that the "cell he occupied in the St. Pierre prison was an un-"derground dungeon, which had no other window than "a grated aperture in the upper part of the door. On "the morning of May 8th, while he was waiting for "breakfast, it suddenly grew very dark; and almost im-"mediately after hot air mixed with fine ashes came "in through the door grating and burned him, he "rushed and jumped in agony about the cell, and cried "for help; but there was no answer; he heard no "noise, saw no fire, and smelled nothing except what "he thought was his own body burning. The intense "heat lasted only a moment and during that time he "breathed as little as possible. There was no smoke in "the cell, and the hot air came in through the door "without any noticeable rush or blast. He had on at "the time hat, shirt and his trousers, but no shoes. "His clothing did not take fire, and yet his back was "severely burned under the shirt. The water in his "cell did not get hot or at least it was not hot when "he first took a drink after the catastrophe.

"We questioned him closely with regard to sounds "and smells, but he continued to insist that he heard "no explosion and that there was no perceptible odor "of gas or sulphur in his cell. Hot air mixed with dust "came in at the grated window in the upper part of the "door and burned him, and that, he said, was all there "was of it.

"This man had not been rescued or heard a sound "till four days after the tragedy and the interview was "two or three days after this."*

As a commentary on this remarkable interview by Mr. Kennan, which will, possibly, never have a duplicate in the world's history, it is well to point out that in the depths of this dungeon there could be no question of direct radiation of heat from the burning gases at the volcano's mouth nor yet, since it was at a remote part of the prison with but one opening, could there be a current of air through the dungeon to bring the hot blast or its heat to him by convection or carrying currents. It leaves us a most remarkable duplication of the conditions of the "fire syringe" of the physics quotation previously mentioned in which the negro takes the place of the tinder, and is frightfully burned by the air of his own cell, as it is compressed by that outside from pressure generated at the crater, and exerting itself in all directions and distances till equalized. There is one question we would add to Mr. Kennan's interrogation, and that would be as to whether the palms of Ciparis' hands were burned, for if not they would indicate that he had covered his face with them, thus accounting, probably, for the reason for the mentioned escape of his face from blistering.

Mr. Kennan further mentions the experience of other victims who experienced partial submission in the compression zone.

"Mr. Lassire and Mr. Slonut were on the edge of the "'Cloud' as it came down the mountainside, overturn-"ing and wrecking their carriage, and setting their "mule free, leaving them stunned, burned, and half "dead, in the shattered vehicle. They state they saw "no flame or fire, did not notice anything like suffocat-"ing gas and smelled nothing except what they de-"scribed as the 'odor smoke from lava.'

"Both felt the intense heat of the blast as it swept "over them, but Mr. Lassire did not realize that he "was seriously burned till he crawled out of the "wrecked carriage. Clothing showed no sign of in-"jury from heat, but their backs were badly burned "or scalded under it. The skin at once peeled from "their hands so that it hung from it in strips, and "when they arrived at Morne Rouge, their shoes had "to be cut from their burned and swollen feet."

Mr. Kennan also mentions ships in the bay on which mattresses down inside the sailors' quarters were ignited while the wood of the vessel escaped.

Mr. Dean C. Worcester in the description of the Taal eruption in the *Geographic Magazine* for April, 1912, gives a similar list of destructive exhibits and gives as the probable cause the sand-blast theory. He writes:

"Most of the survivors were horribly injured; in "numerous instances their flesh was lacerated, and "their limbs were fractured by stones from the vol-"cano, falling timbers of houses or flying debris driven "by the dreadful blasts from the crater, while most "of them had horrible injuries, *the exact nature of "which is in dispute.* They have been almost invaria-"bly referred to as burns, but the fact that the cloth-"ing was not charred in any observed instance nega-"tives the idea that the dead were killed or injured "by fire."

"It was noted furthermore that the bark of the "stumps of trees on the side towards the volcano was "often cut to two, when not completely destroyed, "and that the resulting fine strands of wood fiber "were not burned, and in my opinion there is little "doubt that a large majority of the killed and wound-"ed were injured by what was in effect a gigantic sand "blast. This view is strengthened by the fact that in "many cases the thinnest and most transparent fab-

* This entire incident is open to question, in view of the fact the individual who figures in it is given three different names by as many reporters. The impression prevails in some quarters that the whole story is an invention, and that various imaginative natives used it for their personal advantage.—Ed.

"ries sufficed completely to protect the underlying "flesh. If there had been a blast of hot sand the lace "would have been shredded."

Mr. Worcester's article not only very closely substantiates our theory but corroborates it in the further testimony showing a succeeding period of vacuum while describing a victim's state.

Do not all these effects, which are practically identical, from all their various sources, all leaving the probable cause in hazy uncertainty, seem to demand an answer, and is not the answer in the one conclusion that it is the *air compression*, and its inherent, its *thermo-dynamic adiabatic heat* and its sequel of cooling expansion, with its consequent vacuum, with the motion that accompanies both, which give rise to the destruction and rending. The compression institutes the conflagration and the motion the overturning. All its corelaries tend further to identify its work.

By recognizing this heat action of the air, a means is given of arriving at a measure of the forces involved. In the matter of burns, Dr. Osler gives Dupuytren's list of six intensities of these wounds and observations of these effects. The resultant conditions of fusible and burnable material will give data as to lines of equal intensity of temperature in the region outside that of total destruction. It would also indicate that protection can be gained only in retreats to which pressure can penetrate either not at all or too slowly to be effective, such as a duplicate of the chambers arranged for the treatment of caisson disease, well anchored and heat insulated, of small volume and of great strength to prevent collapse.

In the event of a volcanic catastrophy the theory advanced in this paper is a principle whose application will open a considerable field for observation and comparison, so that we may rate even a volcano.

The matter is advanced with due modesty, but with some confidence as to its explanation of the mechanical and thermo-dynamic side of volcanic results, in the hope that it may cast light on questions that have invariably been asked by narrators and have so far been unanswered.

To sum up our contention, we believe that when a volcano erupts it generates a compression in all the surrounding air and irrespective of the motion set up in that air by the explosion that each particle of it is heated proportional to the pressure under which it moves. That this heating effect extends far beyond the smoke and track of the gases from the crater and due to its great intensity and wide range propagates the fire, blistering and rending effects which all observers have with detail described in practically identical terms and to which no one has assigned as yet a definite and rational cause.

Nuts from the Forests

Native Trees and Shrubs Furnish a Large Variety of Fruits, Nuts, and Other Edibles

It is said that Daniel Boone and some of our other early pioneers could go into the wilderness with only a rifle and a sack of salt and live in comfort on the game and other wild food which the woods afforded. While few people want to try that sort of thing nowadays persons who know the food value of the fruits of our native trees and shrubs are, according to foresters, able to use them to good advantage in supplementing other foods.

NUTS FIRST IN IMPORTANCE

Aside from the numerous edible mushrooms, roots, fruits of shrubs and smaller plants, the trees of our forests afford a large variety of edibles which are highly prized by woods connoisseurs. First in importance, of course, are our native nuts—beech nuts, butternuts, walnuts, chestnuts and chinquapins, hazel nuts, and several kinds of hickory nuts, including pecans. The kernels of all of these are not only toothsome but highly nutritious and are used by vegetarians to replace meat. The oil of the beech nut is said to be little inferior to olive oil, while that of butternuts and walnuts was used by some of the Indians for various purposes. The Indians, it is said, also formerly mixed chestnuts with corn meal and made a bread which was baked in corn husks, like tamales. In parts of Europe bread is made from chestnuts alone. The chestnut crop in this country is being reduced each year by the chestnut-blight disease which in some sections is gradually killing out the trees.

PINES FURNISH EDIBLE SEEDS

Several western pines have seeds which play an important part in the diet of the local Indians. Perhaps the best known of these is the fruit of the nut pine or piñon, which forms the basis for a local industry of some size. Not only is it extensively eaten by local settlers and Indians, but large quantities are shipped to the cities in regions where they grow and the roasted seed is sold on the street. The similar seed of the Parry pine and the large Digger pine seeds are eagerly sought by the Indians. The latter tree is said to have gained its name from its use as a food by the Digger Indians. The seeds of the longleaf pine are edible and are improved by roasting. Indeed, it may be said that most nuts are more palatable when roasted than if eaten raw.

BREAD FROM ACORNS

Acorns are commonly thought to be fit only for feeding hogs, but many kinds of them are either sweet enough to eat or can be made edible from an Indian standpoint and have been used as food, particularly when other foods were scarce. The Indian custom was to pound or grind the acorns up and by treating the pulp with water leach out the tannin, which makes most sorts unfit for eating as they grow. The resulting flour, which contained considerable starch, was made either into a porridge or baked in small cakes. Indian acorn bread is dark in color and to most of us would not seem palatable. As a rule the acorns of the various white oaks having less tannin are the ones best suited for food, but Indians also used those of the black oaks, even though they contain much tannin. The acorns of the basket or cow oak, the chinquapin oak, shin or Rocky Mountain oak, live oak, and of several other species, are sweet enough to be eaten like nuts.

Another nut which is not suited for eating as it grows, but from which a food is said to have been prepared by the Indians, is the buckeye. The kernels of these nuts were dried, powdered, and water was filtered through them to leach out the poison which they contain. The resulting paste was either eaten cold or baked. Attempts have been made in Europe to utilize the horsechestnut as food, but they have not come into use.

MANY USEFUL FRUITS

One of the best-known fruits, the foresters say, is the persimmon, which is edible only after it is thoroughly ripe. As this is usually not until late in the fall, it is commonly thought that the fruit must be frost-bitten. If the persimmon is eaten before it is well ripened, the tannic acid which the fruit contains has a strongly astringent effect, which justifies the story of the soldier in the Civil War who said he had eaten green persimmons so as to shrink his stomach up to fit his rations. The pawpaw, a fruit akin to the custard apple, is also best when thoroughly ripe. Studies of this fruit and its uses have been made by food experts of the United States Department of Agriculture. The fruit of some species of haws is eaten or preserved in different parts of the country, while those of several different kinds of wild cherries and wild currants have a food value and are used for various purposes. Wild plums are abundant in certain sections and occur in particularly plentiful quantities along the streams in the Eastern and Middle Western States. Beach plums are also used for food purposes.

Several varieties of wild crab apples make delicious jellies. Some of the largest, which attain the size of small apples, are more or less abundant throughout eastern North Carolina. Elderberries are frequently used for pies and for sauce. Those found in the West are sweeter and have a better flavor than the eastern varieties.

The berries of the hackberry, or sugar berry, as it is called in the South, are dry but have an agreeable taste. Those of the mulberry are sweet and juicy when ripe. The mulberry is valued in some sections for feeding hogs and poultry and some species are occasionally cultivated.

Many people like the fruit of the shad bush, "sarvice" berry, or June berry, as it is variously called. In parts of the country this fruit is used to make jelly.

EDIBLE BUDS, FLOWERS, AND SEED PODS

The French Canadians are said to use the acid flowers of the redbud, or Judas tree, in salads, while the buds and tender pods are pickled in vinegar. Honey locust pods, often locally called "honey-shucks," contain a sweetish, thick, cheeselike pulp which is often eaten. The blossoms of the common white locust also are sometimes used for making fritters in parts of the United States. Those of the mesquite furnish the Mexicans and Indians with a nutritious food. The Creoles of Louisiana, famous for their cookery, use the young buds of the sassafras as a substitute for okra in thickening soups.—*Weekly News Letter of the Department of Agriculture.*

Appearance of Color Spectra to the Aged

During the latter months of the author's 89th year his attention was directed to a circular color spectrum which appeared to surround any bright light to which his eyes were turned. If he looks steadily at an ordinary electric filament glow-lamp, about 10 feet distant, it appears to be surrounded by a vivid color circle about 2 feet in diameter, with the red band external, the blue internal, the yellow intermediate. The band appears to be about 6 inches in width, so as to be quite clear of the light itself, from which its inner margin appears to be about 6 inches distant. Round a lighted wax match held in the hand the color circle appears to be about as large as a florin, while that around the full moon is very large and of brilliant colors. The author (who retired from practice 15 years ago), has come to regard the color rings mainly as an accidental result of unimportant lenticular conditions, the effects of which are intensified by the use of electric light, but which may be dismissed from consideration so far as the quality or the maintenance of vision is concerned.—Note in *Science Abstracts* on an article by R. B. Carter in *Nature.*

SCIENTIFIC AMERICAN SUPPLEMENT

Founded 1876

NEW YORK SATURDAY, MAY 25, 1918

Published weekly by Munn & Company, Incorporated
Charles Allen Munn, President; Frederick Converse Beach, Secretary; Orson D. Munn, Treasurer
all at 233 Broadway, New York

Entered at Post Office of New York, N. Y., as Second Class Matter

The Scientific American Publications

Scientific American Supplement (established 1876) per year $5.00
Scientific American (established 1845) 4.00
The combined subscription rates and rates to foreign countries, including Canada, will be furnished upon application.
Remit by postal or express money order, bank draft or check.

Munn & Co., Inc., 233 Broadway, New York

The purpose of the Supplement is to publish the more important announcements of distinguished technologists, to digest significant articles that appear in European publications, and altogether to reflect the most advanced thought in science and industry throughout the world.

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